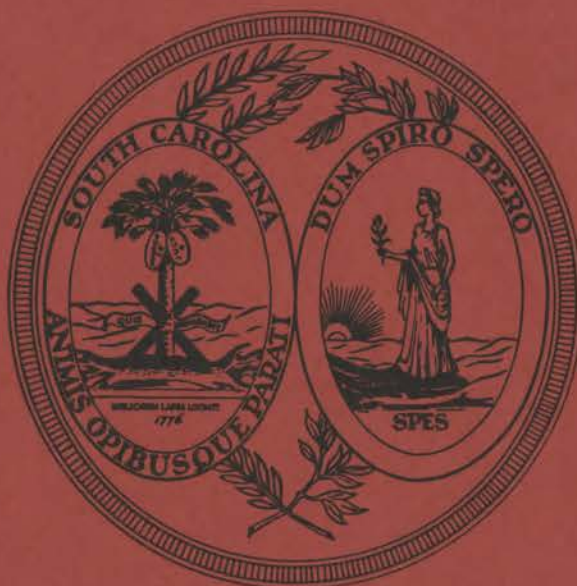


Clemson University



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# CLEMSON UNIVERSITY



## ANNUAL REPORT

1988-1989

Printed Under The Direction Of The  
State Budget And Control Board

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1988/89



PRESIDENT

When you are privileged to be part of a dynamic University community that is doing so much for so many people, enthusiasm for her mission naturally runs high. This sense of achievement, coupled with anticipation of the job to be done in the immediate future, is especially heightened during this time of Centennial celebration.

In the classrooms, the research laboratories and through the outreach of public service activities, Clemson University has touched the lives of untold numbers in ways that founder Thomas Green Clemson probably never even considered. And Clemson's next one hundred years hold even greater promise.

As we cross the threshold into our future, we are taking a blueprint to guide our direction and purpose. Our plan is called "Clemson University: The Second Century." We have identified six emphasis areas as focal points in the University's strategic plan for achieving academic excellence with relevance. These six areas are agriculture and food, engineering and basic science, marketing and management, quality of life, textiles and undergraduate education.

We are eager to share the news of accomplishments of the past year and our hopes for the future. Following are a few examples of programs and research under way in each emphasis.

### **Agriculture and Food**

- Clemson was the site of a seminar — sponsored by the U.S. Agency for International Development — to allow faculty to help third world countries improve their food packaging techniques. Clemson is the only university in the Southeast and one of the few in the country to offer degrees in packaging science.
- Agricultural economists are using sophisticated, large-scale input-output computers in marketing and economic surveys to identify economic trends to help S.C. agriculturists increase viability in the marketplace.
- As alternative enterprises to traditional farming continue to show promise, researchers are working to enhance these new opportunities by developing better ways to cultivate catfish and crawfish and more effective methods to produce other new enterprise crops.

### **Engineering and Basic Science**

- A major research program in carbon fibers and advanced engineering materials deals with high performance reinforcing fibers and has resulted in fibers with vastly improved mechanical and thermal properties.



- In the area of atmospheric and space sciences, faculty are experimenting with radar to study the earth's atmosphere and near-earth space environment.
- Researchers are conducting programs to evaluate advanced materials for implants and other biomedical applications. Projects include development and testing of innovative prosthetic materials to the creation of expert systems that design and rapidly manufacture customized implants.

### **Marketing and Management**

- Support from the 1989 Cutting Edge Research Investment Fund was used to enhance the Manufacturing Management Laboratory in the Department of Management. Concurrent simulations are being conducted of two different computer-based manufacturing planning and control systems, and Clemson students are gaining hands-on experience with both systems. An article describing this laboratory was published in the Winter 1989 issue of *Decision Sciences*, a leading academic journal in business.
- Management professors are contributing a key component to the Apparel Advanced Manufacturing Demonstration project at the Clemson Apparel Research center in Pendleton, S.C., through the development and demonstration of "AMCIA" (Apparel Manufacturer's Capital Investment Advisor), a computer-based decision support system for capital budgeting decisions for apparel manufacturers.
- Clemson management faculty are developing new techniques and computer software for more effective manufacturing scheduling, with more than \$500,000 support by the Defense Logistics Agency.

### **Quality of Life**

- Faculty are investigating the effects of acid rain and ozone on shortleaf pine trees under a comprehensive multi-million-dollar grant from the U.S. Department of Agriculture. Clemson is one of five universities studying the effects that such air pollution may have on the nation's \$38.5 billion forest products industry.
- A Small Town Partnership program established by the College of Architecture helps communities help themselves through assistance in the planning and development of community resources.
- Nursing faculty are studying stress in elderly individuals who are the primary caregivers to aging family members with debilitating diseases and are developing programs to teach them pertinent health care skills.

### **Textiles**

- In the area of robotics in fabric handling, researchers are exploring methods of creating robots that deftly handle limp fabrics for apparel manufacturing, initially focusing on the tasks of turning and pressing shirt collars.

- Computer models are being created that simulate projected production flow and overall operational performance for a plant. Researchers use data from existing apparel plants to develop these simulations which tell management how decisions made today will affect the plant tomorrow.
- Clemson research aimed at improving yarn production and quality involves testing a combination of high-volume instruments to assess the physical characteristics of cotton fibers in large quantities.

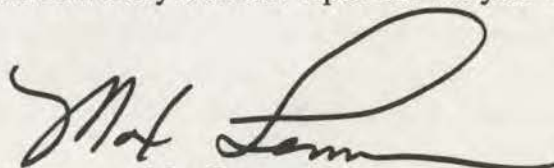
### Students

- A record 2,886 freshmen enrolled for the 1988 academic year. Of those, 33 percent ranked in the top 10 percent of their high school classes, 58 percent were in the top 20 percent, and 94 percent were in the top 50 percent.
- Clemson's Graduate School experienced record numbers of applicants during the 12-month period from September 1988 - August 1989. There were 4,261 applicants for degree programs and 1,071 applicants for non-degree programs, for a total of 5,332.
- The outstanding performance of Clemson's student-athletes in 1988-89 placed our sports program in the top 10 ranking in the nation for the second consecutive year (USA Today's All-Sports Poll) and the seventh time in the last 11 years. Clemson was one of only eight teams in the country to play in a bowl game, the NCAA basketball tournament and the NCAA baseball tournament. Clemson tied the ACC record for overall conference championships last year with seven. The 26 Athletic All-Americans for 1988-89 tied the school record in this category.

### Private Support

- Private gifts for Clemson's academic programs increased by 21.4 percent, reaching \$12.5 million and hitting double digits for the second time in history.
- Unrestricted giving to the annual Loyalty Fund topped \$1.2 million for the first time ever.
- Of Clemson's alumni of record, 28.5 percent — twice the national average for state-assisted schools — participated in the Loyalty Fund.
- The year included announcements of several large contributions from both individuals, corporations and foundations. The establishment of the R. Roy and Margery Pearce Center for Professional Communication, and the establishment of the John Archbold Center for Tropical Studies exemplify two major private initiatives.

I am pleased to present Clemson University's annual report for the year 1988-89.



Max Lennon  
President



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## 1988-89 UNIVERSITY BOARD OF TRUSTEES

Louis P. Batson, Jr., Chairman .....	Greenville
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Buck Mickel .....	Greenville
James C. Self .....	Greenwood
B. Marion Smith .....	Columbia
James M. Waddell, Jr. ....	Beaufort
Allen P. Wood .....	Florence

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William N. Geiger, Jr. ....	Columbia
Paul Quattlebaum, Jr. ....	Charleston
D. Leslie Tindal .....	Pinewood

## ADMINISTRATIVE OFFICERS

### Executive

Max Lennon, Ph.D. ....	President
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David R. Larson, MBA .....	Vice President for Business and Finance
Gary A. Ransdell, Ph.D. ....	Vice President for Institutional Advancement
Jay Gogue, Ph.D. ....	Vice President of Research
Manning N. Lomax, B.S. ....	Vice President for Student Affairs and Dean of Students

### Academic

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Milton B. Wise, Ph.D. ....	Vice President and Vice Provost for Agriculture and Natural Resources



Jerome V. Reel, Jr., Ph.D. ....	Vice Provost and Dean of Undergraduate Studies
Arnold E. Schwartz, Ph.D. <sup>1</sup> .....	Vice Provost and Dean of the Graduate School
Christopher J. Duckenfield, Ph.D. ....	Vice Provost for Computer and Information Technology
Joseph F. Boykin, Jr., M.S. ....	Director of Libraries
Horace W. Fleming, Ph.D. ....	Director of the Strom Thurmond Institute for Government and Public Affairs
James H. Daniels, Ph.D. ....	Acting Dean and Director of Resident Instruction
James R. Fischer, Ph.D. ....	Dean, Agriculture Research and Director, S.C. Agricultural Experiment Station
Byron K. Webb, Ph.D. ....	Dean and Director, Cooperative Extension Service
James F. Barker, M.A. ....	Dean, College of Architecture
Ryan C. Amacher, Ph.D. ....	Dean, College of Commerce and Industry
Gordon W. Gray Ed.D. ....	Dean, College of Education
J. Charles Jennett, Ph.D. ....	Dean, College of Engineering
Benton H. Box, D.F. ....	Dean, College of Forest and Recreation Resources
Robert A. Waller, Ph.D. ....	Dean, College of Liberal Arts
Opal Hipps, Ph.D. ....	Dean, College of Nursing
Bobby G. Wixson, Ph.D. ....	Dean, College of Sciences

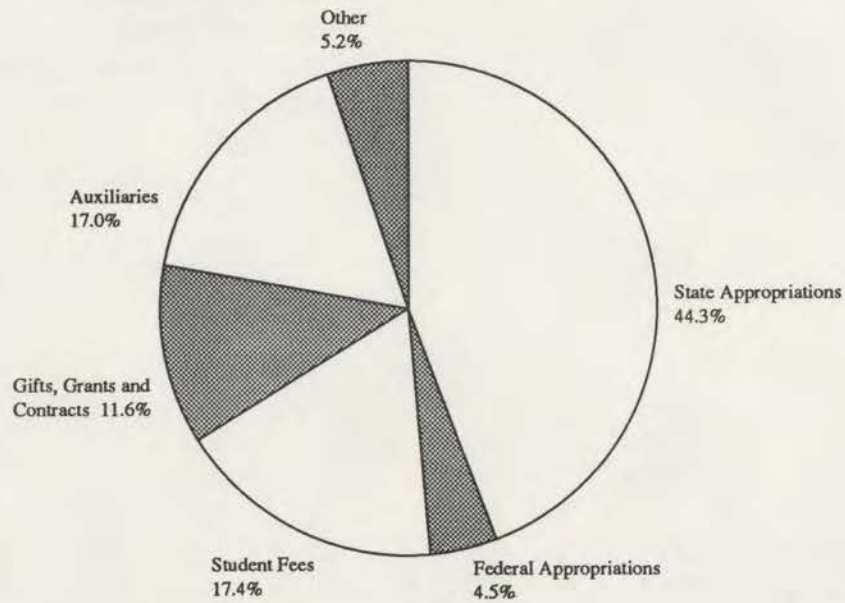
#### **Admissions and Registration**

B.J. Skelton, Ph.D. ....	Assistant Vice President for Student Affairs and Dean of Admissions and Registration
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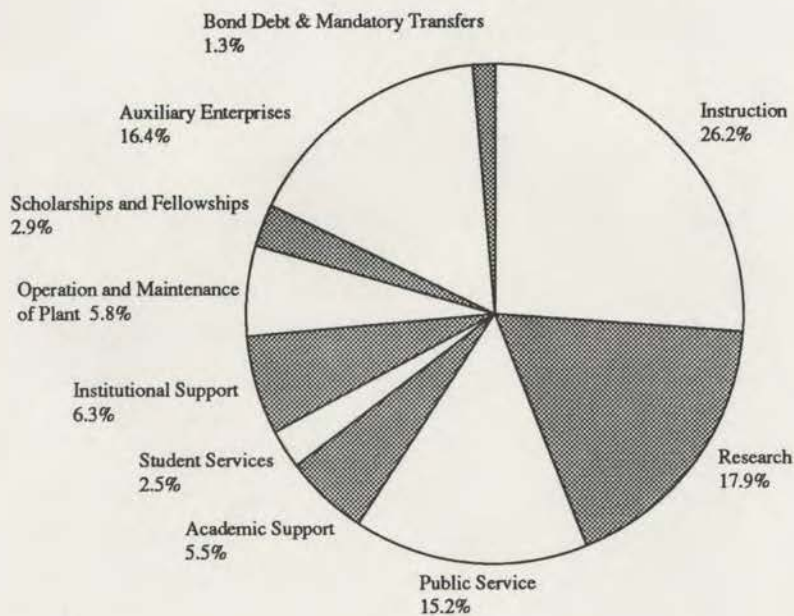
<sup>1</sup> On leave as of July 1, 1989. Farrell B. Brown is serving as acting dean.

# CURRENT FUND REVENUES AND EXPENDITURES FOR THE YEAR ENDED JUNE 30, 1989

## Current Fund Revenues



## Current Fund Expenditures





## COLLEGE OF AGRICULTURAL SCIENCES

The report of 1988-89 activities for the College of Agricultural Sciences' resident instruction, research and Extension programs is included under the Division of Agriculture and Natural Resources on page 71.

## COLLEGE OF ARCHITECTURE

The College of Architecture marked 30 years of service during the 1988-89 Clemson University Centennial celebration. The college tradition of innovation and national leadership was expanded during the year as new programs were added and existing programs strengthened.

The College of Architecture enjoys a nationally prominent position in off-campus programs. In addition to the main campus in Clemson, the college's graduate study center, the Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, and undergraduate study center, the Clemson University College of Architecture Center at the College of Charleston in Charleston, S.C., provide faculty and students with unequalled opportunity for broad educational perspective and enrichment. During 1988-89 the Daniel Center facilities were provided ongoing maintenance support through the Commission on Higher Education funding formula, recognizing the proven quality of this 18-year old graduate study center. The Charleston Center enjoyed its second year, providing 35 undergraduate students with the opportunity to live and study in the architecturally rich environment of Charleston, S.C. A new summer program was added in partnership with the College of Charleston to provide architecture students from across the United States the opportunity to study the culture and architecture of Charleston. This new program was developed by faculty from the College of Charleston and Clemson's Professor Yuji Kishimoto.

The strategic planning process continued during the year enabling the college to develop substance in its newly created programs.

- The landscape architecture program added a new faculty member, Associate Professor Lolly Tai, who joined Professor Don Collins on this faculty. The number of new students selecting the Bachelor of Landscape Architecture degree program required that an additional faculty member be added for the 1989-90 year, and a nationwide search was initiated to identify the third faculty member in the program.
- The second year for the Master of Building Science and Management proved to be significant. This unique graduate program added to its traditional on-campus students a number of off-campus students through the new University Telecampus program. This program provides a statewide opportunity for students to remain full-time construction professionals and still pursue this graduate degree.
- The Bachelor of Fine Arts degree program proved successful in attracting highly qualified students and providing studio teachers the opportunity to direct the efforts



of undergraduate art students for the first time. The foundation this program is providing to the Master of Fine Arts is very important, and together these two programs are building an important presence for the fine arts at Clemson.

- A fourth new degree program was approved by the University and the Commission on Higher Education during the year. The Master of Science in Architecture will enable the Department of Architectural Studies to focus its graduate-level research efforts. Students will be attracted to this program who have a professional architectural degree and who wish to explore a specific research program in which the college has proven expertise, including lighting and acoustics, computer color graphics, architectural theory, health care and energy.

The tradition of teaching excellence in the college continued during the year and was highlighted by the selection of Dr. Roger Liska as the recipient of the John Trimmer Award for Teaching Excellence. This annual national award is given to America's finest teacher in building science. In addition Alumni Professor Peter Lee was selected as one of five national ACSA Distinguished Professors. He joins Alumni Professor Emeritus Harold Cooledge and Dean Emeritus Harlan McClure, FAIA, as college faculty who have received this special national recognition. The College of Architecture has more National ACSA Distinguished Professors than any school of architecture in North America.

The Distinguished Visiting Artists Series was initiated during the year (see Department of Visual Arts and History) and joined the Distinguished Visiting Architects Program in attracting the finest teachers and practitioners to the college for extended periods of teaching and lecturing with students and faculty. TAFT Architects of Houston served as the Distinguished Visiting Architects for the year in Clemson, Charleston and Genoa, Italy.

The college receives excellent leadership from its four department heads and two associate deans. Most are also involved in the key national boards in their respective professions. Associate Dean Lamar Brown directs college instruction, facilities and budget. These internal activities are critical to the progress made during the year. The number of degree programs in the college has doubled in two years, and the resulting growth has put tremendous pressure on current facilities. Dean Brown has enabled the college to move forward under these pressures and will coordinate the renovation of Lee Hall facilities beginning in 1989 and the addition to Lee Hall scheduled for 1992. The support for this addition in the University planning and budget process has given the college faculty and students a significant boost in enthusiasm. Associate Dean Gayland Witherspoon directs the college activities in research, development and public service. These external activities increased dramatically under his leadership, totaling more than \$1.5 million in outside support. These efforts were highlighted by support from the new Cutting Edge funds for economic development through public service design projects in South Carolina communities as well as two major gifts to the college through the Clemson Architectural Foundation's campaign to build the McClure Endowment: a \$100,000 grant from the National Endowment for the Arts and a \$100,000 gift from an anonymous donor. These two gifts combined with previous gifts provided the CAF/McClure Endowment campaign \$300,000 toward its \$500,000 goal.



The college benefits from two outside advisory groups: the Board of Trustees for the Clemson Architectural Foundation, which advises and participates in development activities, and the new College of Architecture Advisory Council, which advises on academic programs, policies and standards. These professionals give generously of their time and experience to strengthen the college and have been integral to the ongoing strategic planning process under way. Together with these advisory groups, faculty, students, staff and alumni have condensed and focused its strategic plan to guide the college's future.

Faculty development remains the issue of highest priority in the college. Progress was made during the year, resulting in increased support for sabbatical leaves, faculty travel, summer research initiatives, faculty retreats on teaching innovation and plans for a special experimental studio. The 12 new faculty added during the year were carefully selected through national searches. All are junior faculty and will add their energy and expertise to the collective experience and tradition of excellence in the college.

### Special Programs

The Clemson Architectural Foundation Lecture Series, supported by donations to the Clemson Architectural Foundation, sponsored the following speakers for the academic year: Yoshinobu Ashihara, Bruno Ast, Katharine Carter, Peter Chermayeff, Arthur Erickson, Jun Kaneko, Ted Kennedy, William M.C. Lam, David Lewis, Christian Norberg-schulz, Eric Renner, Robert Rohm and Ken Tyler.

The Rudolph E. Lee Gallery, Clemson University's art gallery, presented the following exhibitions last year:

September 5 - September 26	Thomas Green Clemson Collection, 17th - 19th c. European Masters' Paintings
September 5 - September 26	Harlan E. McClure, FAIA, Dean Emeritus, Italian Watercolors and Sketches
October 3 - October 24	Clemson, College of Architecture Visual Arts Faculty Exhibition
October 31 - November 21	The Vietnam Veterans Memorial, Photographed by Sal Lopes
November 28 November 30	Student/Faculty Art Sale
December 5 - December 16	Master of Fine Arts Thesis Exhibition
January 9 - January 30	Roger Viellard Retrospective
February 6 - March 3	Clemson's 4th National Print and Drawing Competition
March 13 - March 29	College of Architecture Graduate Student Show
April 3 - April 9	Concept of Dwelling
May 1 - July 28	Summer Show of Student Work



## Architectural Studies

The department received final approval from the Commission on Higher Education for the Master of Science in Architecture degree program. The commission also approved the Bachelor of Landscape Architecture degree program and admitted freshmen into this new program. The department has also received national recognition by being featured in *Architecture* magazine.

Significant faculty accomplishments for the year included:

- Professor Peter Lee, in addition to his role as director of graduate architecture, organized the third annual graduate symposium on ideas in architecture, "Implementing Architecture," held at the Georgia Institute of Technology. Professor Lee also directed the annual Architect's Day events. At the most recent Association of Collegiate Schools of Architecture (ACSA) meeting, he received the national ACSA Distinguished Professor Award; this annual award is the highest teaching award given in architecture education.
- Professor Emeritus George C. Means, Jr., FAIA, was awarded the Order of the Palmetto at the Honors and Awards Day ceremony in April. This is the highest award a citizen can receive from the Governor of South Carolina.
- Professor and Dean James Barker participated as a juror on the Performing Arts Center Jury at Clemson University in April. He also was appointed a member of the National Council of Architectural Registration Boards (NCARB) Professional Conduct Committee as well as currently serving as the Southeast director of the Association of Collegiate Schools of Architecture.
- Professor Don Collins completed his first year as program coordinator for the new landscape architecture degree program.
- Professor Lynn Craig presented a paper, "Tomorrow's Practitioners are Today's Students," at the ACSA Southeast/Southwest Conference and co-authored a paper, "Architectural Settings in Children's Picture Books," under review by Popular Culture Association in the South. He also served as director of the South Carolina Chapter of the American Institute of Architects and as editor of the college journal.
- Professor Durham Crout was one of the speakers at the graduate symposium "Implementing Architecture" held at the Georgia Institute of Technology.
- Professor Martin Davis received a \$125,000 grant from the South Carolina Division of Energy, Agriculture and Natural Resources to develop an advanced course curriculum in energy for the new Master of Science in Architecture degree program. As a result of research from a \$4,200 planning and survey grant awarded to Professor Davis by the South Carolina Department of Archives and History, two historic districts and one building on the Clemson University campus were approved by the State Review Board for listing on the National Register of Historic Places. He also served as the editor of the college newsletter.
- Professor Ray Huff, in addition to his role as resident professor at the Clemson University College of Architecture Center at the College of Charleston, served as a member of the NEA Design Awards Committee and the South Carolina Commission for the Arts Board.



- Dr. Jane Hurt received a Provost Research Grant to further her research on "History Time Line of American School Buildings." She also presented a paper, "Beginning Design," at the ACSA Conference.
- Professor John Jacques completed his first year serving as department head and was one of the speakers at the graduate symposium "Implementing Architecture" held at the Georgia Institute of Technology.
- Professor Yuji Kishimoto organized and directed the second annual "Exploration in Architecture," a two-week architecture camp and an introduction to architecture for high school students. He also coordinated the Southern United States - Japan Architectural Exchange (SUJAE) program.
- Professor Richard Norman presented papers at the Spocade V National Microference at Coeur D'Alene, Idaho; the CAAR Futures '89 Conference at Harvard Graduate School of Design; the ACADIA Workshop '88 at Ann Arbor, Mich.; and at the ACSA Regional Conference on Computers in Architectural Education at the Georgia Institute of Technology. He is also author of a textbook on electronic color to be published.
- Professor George Polk presented a paper, "Vernacular Architecture," at the ACSA Southeast Regional Meeting in San Juan, Puerto Rico, in October. He retired after 13 years of teaching service to the college.
- Professor Ken Russo, in addition to his role as director of graduate architecture and health, coordinated the public service project Inter-American Health and Wellness Community for Advanced Medicine in Caguas, Puerto Rico. He was also appointed to the Board of Trustees of the Health Facilities Research Program (HFRP), which is sponsored by the American Institute of Architects/Association of Collegiate Schools of Architecture.
- Professor Robert Silance attended Cranbrook Teachers Academy in Bloomfield Hills, Mich., during the summer of 1989.
- Professor Lolly Tai received a Provost Research Grant to research the "Public Botanical Gardens to Determine Specific Guidelines for Successful Planning and Design." She also attended the American Society of Landscape Architects National Conference in Seattle, Wash., in November.
- Professor Gayland Witherspoon was named associate dean for development, public service and research for the College of Architecture. He also was elected to the College of Fellows at the most recent meeting of the American Institute of Architects.
- Professor Joseph Young served as the professor-in-residence at the CAF/Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, for 1988-89. He was also awarded Clemson University's Frank E. Burtner Award.

The department initiated its first annual undergraduate spring project, "Concept of Dwelling," which provided the opportunity for undergraduate teachers and students to focus their attention on a contemporary societal problem. This led to a special project with the national organization Habitat for Humanity.



## Building Science

In anticipation of an accreditation visit by the American Council for Construction Education in spring 1989, the department embarked on a comprehensive assessment process in which six general areas were considered: organization and administration, curriculum, faculty, students, facilities and services, and relations with industry. Data from this assessment were incorporated into the self-study report prepared for the ACCE accreditation visit. The comprehensive assessment process will be ongoing. The accreditation visiting team was on campus February 20 and 21, 1989. The preliminary report has been received and reviewed by the department. Official word as to reaccreditation is expected at the national ACCE meeting in July.

During the year the peer review policy of the department was finalized and received approval from the dean and provost.

In September 1988 Clemson University and Associated Builders and Contractors (ABC), Washington, D.C., entered into an agreement wherein Clemson's Department of Building Science and ABC jointly conduct ABC's national management and supervisory educational programs. The department will provide facilities, consultation, administrative support and faculty for non-degree training programs for construction managers, project managers and supervisors. During fall 1988 and spring 1989 eight academies were held at Clemson's Outdoor Laboratory.

The S.C. Home Builders Association and the department co-sponsored the Graduate Builders Institute at Clemson University. The first series of three courses was held in October 1988, and the second series was held in March 1989. Department faculty taught in these courses, and plans are under way to continue this sponsorship.

Through donations from alumni, industry and friends of the department and matching funds from the University, a Materials Testing Laboratory was established for the department. Additional equipment will be purchased as funds become available.

The University's Telecampus network was utilized to offer CABS 865 Project Management in the fall 1988 semester and CABS 861 Construction Control Systems in spring 1989. The network currently consists of six receiving sites across the state: Aiken, Charleston, Florence-Darlington, Greenville, Greenwood, Rock Hill. It is anticipated that beginning with the fall 1989 semester, an additional site will be added in Columbia. A number of construction professionals throughout the state are pursuing their graduate degrees in this manner.

The department maintained the S.C. Licensing Examination for Contractors and has prepared a proposal to rewrite the exams and continue maintenance for the next three-year period.

After a thorough search and screening process, permanent positions at the assistant professor level were offered to Gregg Corley and John Mumford and were accepted.

Significant faculty accomplishments and activities include:

- Professor Francis Eubanks' paper, "Financial Ratios for Contractors," presented at the SE Regional Meeting of Associated Schools of Construction, Savannah, Ga., was selected for and presented at the National ASC Meeting in April 1989.
- Dr. Roger Liska received the John Trimmer Excellence in Teaching Award from The Merit Shop Foundation, March 1989.



- Professor Eubanks was awarded the first Faculty Enhancement Award in May 1989 by the department's Industry Advisory Committee. He will receive a stipend of \$2,000 for his research on financial ratios.
- Dr. Liska was elected to a three-year term as a national director of the American Institute of Constructors at their meeting March 30 - April 4, 1989.
- Professor Steve Schuette's research proposal, "Production Allocation for a Specialty Contractor," was funded by DeFlavis Brickwork Co.
- Dr. Liska authored and submitted a research proposal on "Employee Incentive Program Applications for the Small to Medium Size Construction Firm." This proposal has been funded (\$5,000) by the Construction Industry Cooperative Alliance.
- The research proposal on "Absenteeism and Job Turnover," funded by Associated Builders and Contractors in the amount of \$5,000, was completed.
- Professor Clarence Addison attended the Architectural/Engineering and Construction Systems Conference, Chicago, 1988.
- Dr. Norman Book received a full fellowship from the Association of Collegiate Schools of Architecture to attend the 1988 ACSA Construction Materials and Technology Institute at Massachusetts Institute of Technology.
- Professor David Egan attend the NSF Workshop on Research Needs for Masonry and participated in a video course on fire-safe building design, Emmitsburg, Md., April 1989.
- Professor Steve Schuette serves as regional director, national board member and chairs the National Industry Relations Committee of the Associated Schools of Construction. He was responsible for planning and facilitating the regional meeting held in Savannah, Ga., October 1988.
- Faculty actively participated in the South Carolina Piedmont Chapter of the American Institute of Constructors. During the year Professor Francis Eubanks served as secretary-treasurer of the chapter, and Professor Steve Schuette served as vice president.
- Professors Liska and Schuette are active at the national level with the American Council for Construction Education. Dr. Liska serves as national vice president, board member and chairman, National Planning Committee; and Professor Schuette chairs the ACCE Standards Subcommittee. During the year Professor Schuette chaired the Accreditation Visiting Team to the Construction Program at Florida International University, and Professor Liska chaired a team to the Construction Program at Purdue University.
- Professor Egan served on the Architecture Program Advisory Board for Savannah College of Art and Design, as a member of the AIA Crisis Management Advisory Group, the Editorial Advisory Board for *Architectural Lighting* and as associate editor of *Noise/News*.
- Professor Schuette is a member of the National Educational Advisory Committee of The Merit Shop Foundation.



## Planning Studies

The 1988-89 academic year was a successful one for the Department of Planning Studies. For the first time since 1984-85, all five positions were occupied by full-time, tenured or tenure-tracked faculty, allowing new initiatives to take place. Actions were launched on several areas, principally curriculum review, recruiting efforts, research and public service, and scholarly and professional development activities.

The curriculum, last revised in 1980-81, underwent exhaustive study in light of accreditation standards as well as current trends in planning education.

Several research and public service projects and grants totaling \$375,800 were attracted to the department during the year, generating external funding for 13 graduate students as well as opportunities for classroom activities.

Faculty accomplishments were as follows:

- Professor Jose Caban was elected chair-elect of the American Planning Association Urban Design and Preservation Division for the 1991-93 term, following his position as secretary-treasurer. He will become editor of the *Urban Design and Preservation Quarterly*, a national journal for which he presently serves on the Board of Editorial Advisors. The journal will be published in the College of Architecture. Professor Caban has continued as editor of *The Palmetto Planner*, the quarterly review of the South Carolina Chapter of the American Planning Association; was invited to serve on a panel for the Massachusetts Artists Foundation on the topic "Design and Built Environment"; was appointed to the Clemson Downtown Revitalization Committee and to the city of Clemson Building Board of Appeals; serves on the Council of Academic Advisers of the Strom Thurmond Institute; and is the secretary of the Executive Committee of the Organization of Academic Department Heads of the University.
- Professors Jose Caban and Barry Nocks attended the 30th Association of Collegiate Schools of Planning Conference in Buffalo, N.Y., where they presented two co-authored papers: "Transportation Improvements and Land Use Incentives" and "Introducing Strategic Planning in a Planning Curriculum."
- Professors Jose Caban and James London attended the American Planning Association National Conference in Atlanta in April.
- Professor James London published a report, "The Impact of Clemson University on the State of South Carolina: A Centennial Report," Clemson University, March 1989. He will present a paper, "Consolidating Traditional Impact Assessment Techniques with GIS," November 1989 in Santa Barbara, Calif., with Professors Kerry Brooks and Mark Henry. Professor London conducted a workshop on benefit-cost analysis at a U.S. Forest Service training program held on campus; wrote a book review on *Canada's Resource Industries and Water Export Policy and The State of the Rio Grande*, in the *Journal of Regional Science*, November 1988; published a paper, "Comparative State Water Policy in the U.S.," *Proceedings of the International Water Resources Association*, 1988; co-authored a report, "Water Policy Options for the State of South Carolina," through the Strom Thurmond Institute for the South Carolina Water Resources Commission; is a



Fellow with the Strom Thurmond Institute, Clemson University; served on the State Scenic Rivers Advisory Committee; is an adviser to the South Carolina Water Resources Commission; and has served as an adviser to the State Development Board for the establishment of a state GIS database for infrastructure and economic development planning.

- Professor Barry Nocks presented the paper "The Medically Indigent — Not Just Someone Else's Problem" to the Western Carolina's Torch Club; published the book review on *Health Care and Its Costs*, edited by Carl Schramm in the *Journal of the American Planning Association*; taught a one-day seminar on "Strategic Planning: Focusing on Opportunities for Action," sponsored by the Division of Human Resources of the South Carolina Budget and Control Board; delivered the keynote address to the South Carolina Gerontological Society's Annual meeting; and is currently working with the Greenville Hospital System to obtain federal public health service funding for a community health center to serve medically indigent residents of Greenville County.
- Professor Herbert Norman's proposal for a HUD grant was funded to allow the department to fully support three minority students over their two years of study. Only a few schools in the country were selected for these grants, making it an honor which recognizes the department's efforts in affirmative action in recruiting and retention of minority students. He gave two invited lectures in the Department of Architectural Studies on "The Planning Department and the Profession" and "Housing Issues for the Concept of Dwelling."
- Professor Kerry Brooks conducted a workshop on Geographic Information System (GIS) at a U.S. Forest Service training program held on campus. He conducted, with Professor Peter Lee, a study for Anderson County Planning and Development Board for development options for the former county farm property.

The five faculty in the department submitted proposals for papers for the forthcoming 31st Annual Conference of the Association of Collegiate Schools of Planning in Portland, Or. Each paper submitted was accepted for presentation, a first and quite significant achievement.

### **Visual Arts and History**

The Visiting Artist Program featured visits from regional, national and international artists who delivered lectures, seminars and workshops. Included in this program were Sue Coe, Phil Davis, Robert Rohm, Ken Tyler, Robert Cumming, Norm Schulmann, Jun Kaneko and others.

The visual arts studio faculty were invited as visiting artists to the University of South Carolina Art Department. The USC faculty will be visiting artists at Clemson in the 1989-90 academic year.

Student reports and evaluations confirm the high level of teaching in the department and the strong commitment that the faculty in both studio and history have to their teaching responsibilities. Large class sizes and strained space needs can be problematic and challenging to the continued excellence in instruction in the department.



The studio art faculty participated in numerous state, regional and national art exhibitions in addition to Clemson's Lee Hall Gallery Exhibition in October 1988. This exhibition provided an excellent format for student-faculty exchange, as the creative research of the faculty was on display.

Examples of studio and history faculty research and creative activity included:

- Professor Janet LeBlanc was awarded an NEH Grant for travel to Sweden for her research on Baroque ship architecture.
- Professor Syd Cross exhibited her prints and drawings in two national exhibitions, one in Gainesville, Fla., at the Sante Fe Gallery and the other at Northern Arizona University Art Gallery. Her work is also included in a major regional traveling exhibition, "Southern Narrative."
- Professor Jon Meyer published articles and art reviews in national periodicals, including *Art News* and the *New Art Examiner*.
- Professor Sam Wang, a recipient of an NEA/SAF Fellowship, was published in *Art Papers*, and his photographic work was included in the NEA/SAF traveling exhibition. Professor Wang also organized and coordinated the Beyond the Zone System Workshop held at Clemson University in March. This national workshop drew participants from Michigan, Missouri, Florida and the Southeast.
- Professors Mike Vatalaro and Syd Cross were selected for the first Artist-in-Residence Exhibition at the Greenville County Museum of Art.
- The research work of Professor Cecilia Voelker was included in two recently published books, *Sapelo: A History* and *San Carlo Borromeo*. This research is on the quarantine stations of the Middle Atlantic and Southeastern states and the work of Borromeo.
- Professor Sam Wang's work with computer applications to visual arts has resulted in numerous periodical articles, an invitation to teach a computer graphics workshop at Virginia Intermont College and the creation of a new course to be offered this fall at Clemson entitled The Computer as a Tool for Art.

The faculty of the 1989 S.C. Governor's School for the Arts included five 1988-89 faculty from the Department of Visual Arts and History: Professors John Acorn, Tom Dimond, Terry Jarrard-Dimond, Mike Vatalaro and Linda Varkonda. This Clemson representation far exceeds the invitations extended to other state art departments and reflects the high quality, respect and recognition of the department faculty.

## COLLEGE OF COMMERCE AND INDUSTRY

### Accounting

In April the School of Accountancy was recognized by the Accreditation Council of the American Assembly of Collegiate Schools of Business with separate accreditation of the undergraduate and graduate programs in accounting. The school joins only



78 schools nationally that have separately accredited accounting programs. The accreditation reflects most favorably on the quality of faculty, students, curriculum and support, and represents a major achievement for the school. In May the South Carolina Commission on Higher Education approved, effective with the 1989 fall semester, the school's application to offer the Master of Professional Accountancy (MPAcc) program in Greenville via the Greenville Higher Education Center.

During the 1988-89 academic year the school graduated 89 B.S. students and 21 MPAcc students. Of the B.S. students 25.8 percent graduated with University honors. Placement results indicate that 34.8 percent of the B.S. graduates accepted positions with CPA firms, 13.5 percent with industry and 12.4 percent pursued graduate study. Of the MPAcc graduates 95.2 percent were placed at graduation, with 71.4 percent of the graduates joining CPA firms. Placement of the undergraduate and graduate accounting students compares favorably with national averages. The school continues to be recognized as a primary recruiting school for major accounting firms in Georgia, South Carolina and North Carolina. Separate accounting accreditation should enhance this status. Enrollments in the B.S. and MPAcc programs continue to grow, with another record number of students anticipated for the 1989 fall semester. Performance on the CPA examination is improving slowly. Recently implemented curriculum changes and a non-credit CPA review course should help improve performance on the CPA exam.

Faculty research productivity continues at a strong pace. During the year the faculty had 25 journal articles and three books published or accepted for publication and presented 13 papers at professional accounting meetings. Faculty publications included articles in *Contemporary Accounting Research*, *CPA Journal*, *Management Accounting*, *Real Estate Securities Journal*, *Internal Auditor*, *Journal of Financial Planning*, *Journal of Information Systems*, *Journal of Commercial Bank Lending* and *Controller's Quarterly*.

The internal auditing program continues to grow, with significant enrollments in all classes and a most successful year in placing students in summer internships and permanent positions. Professor G. Thomas Friedlob was recognized by the National Association of Accountants with two awards for manuscripts submitted to *Management Accounting*. One article received the Lybrand Silver Medal as the second best manuscript submitted to this leading management accounting journal. A second manuscript was recognized with a Certificate of Merit from NAA. Professor Vincent Guide was again recognized by the Calhoun College Honors Program for his excellent classroom instruction in honors sections of accounting principles.

National recognition was once again brought to the school by the Clemson Chapter of Beta Alpha Psi, the national honorary and professional accounting fraternity. For the third consecutive year this student organization earned a superior chapter award in the national competition, the highest recognition a local chapter can receive. The award also brings two \$500 scholarships to members from the Peat Marwick Main Foundation.

In the professional service area five faculty serve on national committees of professional accounting organizations. Several hold office in local and state chapters of professional accounting organizations.



## Economics

The 1988-89 year was exceptional for the Economics Department. Private support for the department reached new heights. Continuing contributions by the Sarah Scaife Foundation, the Earhart Foundation, the Linda and Harry Bradley Foundation, Liberty Fund, Tom. C. Breazeale and the DuPont Corp. were joined by a \$250,000 gift from the Harris Family Endowment. The Harris family had previously endowed a fund to support an annual seminar series for seniors in economics. Each year the department will bring in a nationally known economist to give a series of lectures and to interact with students and faculty.

Visitors were also a highlight of the year. Foremost was Nobel Prize winner George J. Stigler from the University of Chicago, who gave one of the four University Centennial lectures. Charles Cox, one of Stigler's former students and currently a commissioner at the Securities and Exchange Commission, gave the annual economics club lecture. In addition the department hosted seminars by researchers from Stanford, University of Washington, both USCs, Montana State, N.C. State, Texas A&M, Auburn, Oxford University and the U.S. Department of Housing and Urban Development.

Scholarly production reached new heights. More than 70 articles and books were published or accepted for publication during the year, many in top economics journals. Forty undergraduate, six master's and one Ph.D. degree were granted.

## Finance

The Department of Finance continued to be among the nation's leaders in undergraduate finance education. Growing to more than 900 majors, the financial management program became the third largest major at Clemson University and is as large as other finance programs at universities twice the size. Finance graduates continue to be highly sought by firms throughout the nation. This is partly because FM majors take a more rigorous program of accounting and finance courses than finance majors at any other university.

Clemson's finance faculty strive to conduct research that is both relevant and of value to students in the classroom. Our research success hit a dramatic high this year. Mark Mitchell, who is on leave to the Securities and Exchange Commission, wrote two papers receiving worldwide attention. His "trigger paper" is the first explanation of the October '87 stock market crash that relies on market forces. It will appear in the *Journal of Financial Economics*. His "bad bidders" paper will appear in the prestigious *Journal of Political Economy* and explains how firms that execute poor takeovers soon become takeover targets themselves. These papers have been the subject of *Wall Street Journal* stories and editorials. Professor Mitchell will speak on takeover issues at a symposium held by the National Bureau of Economic research in August.

Other faculty members have had similar research success this year. Professor Harold Mulherin's merger and acquisition papers have had wide acceptance. He won the second place award in this year's Credit Research Center competition at Purdue University for a piece on foreclosure laws. Professor Scott Barnhart's paper on commodity prices was published in a major journal, the *American Journal of Agricultural Economics*. Another of his theoretical papers was published by the *Review of Economics*



and Statistics. In addition to a paper in the *Quarterly Review of Economics and Business*, Professor Mike Spivey published his research on call provisions in municipal debt contracts in the *Journal of Financial Research*. His proposal for research into the effect on bank profits of exchange rate changes won the first annual NCNB Summer Research Award.

In the area of private financial support for the year, NCNB's further commitment of \$150,000 to the college will provide five major scholarships in finance and fund faculty summer research.

## Management

The Department of Management continues to integrate industrial management and information technology. The Expert Systems Laboratory, originally equipped with an IBM 4341, has been upgraded with an IBM 9370 mid-range mainframe computer. A new graduate course, Business Expert Systems (MGT 818), has been designed and is now approved. Hands-on laboratory experience in artificial intelligence and expert systems has been included in graduate and undergraduate courses in information technology. This laboratory appears to be the only one of its kind concerning the mainframe application of artificial intelligence techniques in a business school.

Quality teaching and research continued to be a primary goal of the department. A new course, Industrial Traffic Management (MGT 426), has been designed, approved and will be taught for the first time in the fall of 1989. This will give the department a 15-hour area of concentration in transportation and logistics. Five Industrial Management Research Awards were granted to Management faculty this summer. The funded research covered the following subjects:

- The Measurement of Physical Distribution Productivity among South Carolina Manufacturing Companies
- The Use of Knowledge Bases/Expert Systems in the Development of Employee Disciplinary Policies
- Heuristic Proposal for Freezing the Master Production Schedule in the Multi-Item Production Environment
- The Development and Evaluation of Methods for Establishing Group Policy Using Expert Systems Models and Developing Methodology for Predicting Decision-making Effectiveness
- Identifying and Responding to Personnel Shortages and Skill Deficiencies: A Field Study of Greenville County, South Carolina Manufacturers

Department faculty continued to be active in publishing. Contributions by the faculty appeared in such publications as *Harvard Business Review*, *Decision Sciences*, *Personnel*, *Board Room Reports*, *Success*, *International Journal of Man-Machine Studies*, *Interfaces*, *Information and Software Technology*, *Industrial Marketing Management*, *Internal Auditor*, *Human Relations*, *International Journal of Management*, *Academy of Management Journal*, *Journal of Business and Psychology*, *Journal of Marketing for Higher Education*, *International Journal of Production Research*, *Journal of Marketing*, *Personnel/Human Resource Management*, *Industrial and Labor Relations*



*Review, Production and Inventory Management, Industrial Relations, Networks, Computers in Personnel, Journal of Business Ethics, Business Insights, Psychological Reports, Journal of Education for Business, Academy of Management Review, Journal of Managerial Issues, Academy of Management Executives, Strategic Planning Management and the Journal of Operations Management.*

The award-winning IBM Manufacturing Management Laboratory continues to support teaching and research in information technology and manufacturing management.

One new faculty member, Dr. Astrip Lipp, has been hired for the fall term. Dr. Michael J. Stahl, department head, is moving to the University of Tennessee to be associate dean.

## **Marketing**

The Marketing Department, the newest department in the College of Commerce and Industry, continued its rapid growth in the 1988-89 academic year. The department saw an approximate 90 percent increase in the number of students during the past year. More than 80 students received the Bachelor of Science degree in marketing. In addition, students from all majors, as well as other colleges, continued to use elective hours to take marketing courses.

Two new tenure-track faculty members have been added to the department, bringing the total full faculty to 11. One of the additions is the new department head, Dr. Norman Kangun. Dr. Kangun comes from the University of Houston in Texas. Also, Dr. Charles Duke joined the Marketing Department after serving on the faculty at the University of Texas at Arlington.

During 1988-89 a number of marketing classes received significant publicity for projects performed for the business community. Professor McClung received a third year of funding for a project that seeks to improve retention rates for minority students at Clemson University. The faculty was particularly active in research publications. Research was published in 12 marketing journals, including the *Journal of Public Policy Marketing, Journal of Consumer Affairs, Journal of Business Logistics, Journal of the Academy of Marketing Science* and *Journal of Business and Industrial Marketing*. In addition, the faculty presented numerous papers at national meetings.

Faculty also served on committees of professional, regional and local marketing organizations.

## **School of Textiles**

During the 1988-89 academic year the School of Textiles hired a new director, Dr. Douglas V. Rippey, a 1964 textile management graduate and a recipient of the Ph.D. in engineering in 1974. Dr. Rippey will bring to the school the benefits of a career as an Air Force officer and experience as an outstanding classroom teacher at the University of Dayton.

Dr. E.A. Vaughn will return to classroom teaching and research duties after completing a sabbatical study period and speaking tour of the Far East and Europe. Dr. Vaughn served as director for 12 years. During his administrative tenure, renewed emphasis was placed on undergraduate enrollment, sponsored research, faculty recruitment, facility improvement and industry interaction.



During the past year student enrollment in School of Textiles reached 200. This three-decade record level is due mainly to the successful high school visitation and recruitment program carried out by Gladys Conte over the past two years. Ms. Conte recently left Clemson to pursue a textile management career. Our visitation and recruitment program, however, will continue under the leadership of Tracy Page. Current emphasis in this regard is to expand enrollments in textile chemistry and textile science.

Sponsored research in textiles continues to expand as faculty become more involved in proposal writing and industry concerns for the future. Presently, research in textiles leads the University on a per-faculty-member basis. Expansion is anticipated in the areas of apparel, fiber evaluation, process evaluation and product development.

Three named professorships in textiles were recently announced. Drs. Michael Drews and Christine Jarvis have been named J.E. Sirrine Professors of Textiles, and Dr. Clarence Rogers has been named J.W. Swetenburg Professor of Textiles. Joining Dr. Rippy as a new textile faculty member is Dr. Slobodana Rose Matic. Dr. Matic is a graduate of Belgrade University, where she also earned her Ph.D. Her areas of specialty include fiber science and knitting.

Additions to textile capabilities over the past year include expanded analytical instrumentation, fiber processing machinery and state-of-the-art computer-aided design software and hardware. New courses in carpet manufacture and geotextiles were introduced at the undergraduate and graduate levels.

### **Professional Development**

With training and adult continuing education becoming increasingly important in the "Information Age," it is good to report that the College of Commerce and Industry is one of the Southeast's primary providers of quality learning opportunities.

Almost 19,500 business men and women attended seminars, conferences, workshops and in-plant training sessions offered in 1988-89 by the Office of Professional Development (PD).

PD's four major educational product lines — textiles, management, personal computers and in-house — maintained steady growth rates in markets ranging from Boca Raton, Fla., to San Francisco, Calif., to Lansing, Mich., and Washington, D.C. The majority of Professional Development training, more than 1,000 training events this year, was conducted in the Southeast.

Numerous successes marked Professional Development's year, enabling management to upgrade its computer operations by purchasing a mini-computer with relational database capability for more sophisticated and efficient marketing, registration, accounting and scheduling.

Each of the product lines contributed highlights as well. Textile Assistant Director Jud Hair initiated a new "Fundamentals of Apparel" conference in conjunction with the unveiling of the University's \$10 million Apparel Research Laboratory in Pendleton, S.C. This new event reached capacity enrollment (50 participants) almost immediately and prompted two subsequent sessions.

Other programs reached out to encompass new and timely topics in the textile area, including a workshop in Melbourne, Fla., on "In-plant Extrusion of Polypropylene" and



one on "Thermoplastic Reclamation" in Charlotte, N.C. In June textiles observed the 20th anniversary of the unique Nonwoven Fabrics Forum as another large group of participants (138) came to Clemson from as far away as Canada, Mexico and Great Britain. The Tire Industry Conference brought recognition to Clemson in an area not normally considered a strength of the University. This event, in its sixth year, has evolved from a program concentrating on the textile components of automobile tires to a broad-based industry program addressing topics from thread wear to rubber compounding.

While textiles attracted a total audience of approximately 2,800, management, under the guidance of Assistant Director Helena Douglas, was reaching more than 4,500 attendees interested in subjects such as "Improving Purchasing Performance," "Preventive Maintenance," "Computer Operations Management," "Managing Priorities" and "Professional Development for Women."

"Professional Development for Women" fared exceptionally well, drawing record audiences in several of the nine conferences held this fiscal year. Test conferences in places not normally considered a bedrock of Clemson support like Lansing, Mich. and Rockville, Md., (243 and 276 participants, respectively) offered encouragement for the future expansion of this series.

In-house training, also managed by Ms. Douglas, continued to prosper, with training conducted for 132 customers during 478 training days. More than 3, 200 managers and executives participated in the training.

Meanwhile, Associate Dean and PD Director Ralph Elliott continued to attract capacity audiences at his seminar, "Increasing Registrations and Revenue Through Effective Seminar/Conference Marketing." An overflow response of 45 participants in February in Ft. Lauderdale, Fla., prompted Dr. Elliott to host a second session and boosted the yearly enrollment in five sessions to 177 people.

In addition, Dr. Elliott spearheaded the college's development effort, helping the college generate more than \$1 million in gifts, more than half of which was from business and industry. The success of this effort led to the hiring of a permanent director of development beginning September 5, 1989.

In personal computer training headed by Assistant Director Conrad Stuntz, more than 8,300 people enrolled in one-, two- and three-day seminars on subjects such as Lotus 1-2-3, dBASE IV, DOS, Symphony, WordPerfect, Excel, Pagemaker, Ventura, Freelance, Statgraphics and Primavera.

Project Management and Statistical Quality Control, traditionally strong courses, continued to attract high enrollments from among the Southeast's engineering population, garnering 471 and 450 participants respectively. Desktop Publishing, featuring Pagemaker, Ventura and Wordperfect 5.0, proved popular in the seven-state (Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Ohio and Washington, D.C.) marketplace Clemson serves with this product line.

As in the past, PD continued to reach out to the international marketplace, once again hosting a group of 24 British executives for two weeks of management training in Clemson. These "fast-track" managers from Courtaulds, Plc, the world's second largest textile corporation, were grounded in the principles of renaissance management, assertiveness, total customer responsiveness, oral presentations and more.



## **Small Business Development Center (SBDC)**

The Clemson University Regional Small Business Development Center continued to assist the small business community in the 11 northwestern counties of South Carolina. Through its administrative offices located on campus and three area offices located in Greenville, Spartanburg and Greenwood, the SBDC has fostered economic development and growth. During the past fiscal year the Clemson SBDC has assisted more clients than in any of its previous 10 years. Trends indicate that the Clemson SBDC operation will conclude the year at more than 200 percent of annual deliverable goals. In addition, the Continuing Education Division conducted more than 20 seminars on relevant small-business management topics.

The center administers a Defense Logistics Agency grant for the establishment of a federal procurement assistance program for small businesses. As a result of this program, now in its third year of operation, several large procurement contracts should be awarded to small businesses in the Clemson service area.

The Clemson SBDC continued to move into areas beyond its core mission. SBDC staff members have been actively involved over the past two years with a W. K. Kellogg Foundation grant for rural leadership education. The close partnership with the Clemson University Emerging Technology Development and Marketing Center remains strong. Stronger working relationships have been established with several other state agencies such as the State Development Board, the Governor's Office and the South Carolina Economic Developer's Association. The SBDC has remained highly visible on campus and has maintained its association with other departments and colleges during the past year.

## **COLLEGE OF EDUCATION**

During the past year committees of faculty and administrators conducted in-depth studies of the operation of the College of Education, particularly with regard to the effectiveness of its organizational and governance structure in responding to the requirements of state educational improvement laws, such as the Education Improvement Act and Target 2000.

Early results of these studies indicated a need to focus on ways to improve the efficiency and flexibility of internal administration and communication procedures; curriculum supervision and revision processes; extension services, field experience program, public relations activities; and research and development capabilities. Accordingly, the revised organizational structure includes an associate dean, a director of field experiences, a director of extension and public relations, and a director of research and development. Six new faculty positions were added to conduct expanded program offerings and keep pace with the ever-increasing teacher education requirements of South Carolina public schools. A computer networking system was installed to provide faculty and staff with individual access to terminals and full computer-oriented capabilities.



In response to the growing demand for advanced courses of study and additional teacher preparation options, new programs are currently under study in science education, educational administration, curriculum and instruction, and special education. One of the earliest priorities in the coming year will be the integration of teaching critical and higher-order thinking skills into all teacher education programs and courses. Last year the College of Education was reaccruited with full approval by the National Council for the Accreditation of Teacher Education (NCATE).

### **Instruction**

With its nationally and state-accredited teacher education programs at the undergraduate and graduate levels, Clemson's College of Education offers a variety of programs designed to meet the growing demand for competent teachers and professional service personnel for schools from kindergarten through university levels. Preparing more certified educators than any other undergraduate program in South Carolina, the college is the state's major producer of math, science and vocational/industrial technology teachers.

The college also offers an outstanding graphic communications program, which prepares students for professional careers in the printing/publishing/packaging industries.

Clemson's teacher-preparation programs have long stressed in-depth study in subjects to be taught and extensive practical experience in the laboratory and in the field. As a result, secondary education students essentially have a double major — one in the subject area and one in education. A concentration of subject area study is also required by the elementary education program. Thus, a major portion of the rigorous teacher preparation curricula is taught by Clemson's faculty in other departments.

During the past year approximately 1,270 placements of various types were made in the College of Education's laboratory-centered teacher-preparation programs. Placements ranged from full-day, 12-week student teaching assignments for 350 student teachers, to shorter-term tutoring activities for individual children, as well as specially identified groups for instructional purposes.

The facilities and services of the Learning Resource Management Lab were made available on a 12-hour daily schedule to help students upgrade their basic skills. The program served approximately 150 students per week. Graduate and undergraduate classes also used this laboratory for hands-on instruction in educational applications of computers.

Funding for the South Carolina Center of Excellence in Math and Science Education, a joint project of the College of Education and the College of Sciences, was renewed by the State Commission on Higher Education following an intensive on-site evaluation. The project is designed to increase the number of public school teachers certified to teach math and science and to upgrade the skills of in-service teachers in these disciplines.

The College of Education received an increasing number of grants during the 1988-89 academic year, in the areas of minority certification, computers, adult literacy, vocational training and homework assistance.

In conjunction with a University-wide committee, the College of Education has taken a leadership role in establishing exploratory criteria for developing the model schools



project with a prominent foundation. Still in the developmental stage, the project holds great potential for strengthening the ties and effectiveness of University resources in creating more responsive and successful public school systems.

A preliminary proposal was presented to the Commission on Higher Education for establishing a Ph.D. program in curriculum and instruction at Clemson. After further development, a formal proposal will be presented for approval effective for the 1990-91 academic year.

A formal proposal was submitted to the Kellogg Foundation to address the needs of at-risk youth. With an unacceptably high percentage of its youngsters dropping out of school before graduation, the state of South Carolina stands to profit not only educationally but economically, socially and culturally with the realization of this project.

Faculty service included the publication of books, chapters, articles, instructional and self-help materials, editorships of newsletters, guest editorships of professional journals, membership on editorial review boards of national publications and a variety of staff development offerings throughout the region. In addition, faculty made scholarly presentations at local, state, regional, national and international meetings.

The College of Education continued to sponsor a growing number of other annual events, including the S.C. Council for the Social Studies Annual Conference, the Young Authors' Celebration and Leadership Conference.

The Department of Industrial Education continued to make significant contributions toward its primary mission of instruction, public service and research. Several of the noteworthy accomplishments in the area of teaching are reflected in the data related to on-campus and off-campus enrollments for the year. The 14 faculty and 8 part-time adjunct faculty taught 42 undergraduate courses and 22 graduate-level courses during the year. There were 127 classes with more than 1,800 students enrolled.

Faculty continued to provide services to public schools, technical colleges and industry during the year. One public service activity included special institute courses for teachers, vocational administrators and industrial workers. Special institutes were held for 50 industrial technology teachers in a continuing effort to update and retrain all industrial arts teachers in the state. About 100 adult educators were provided a special institute course, which brought the educators together with representatives of industry in the industrial environment.

A specific effort designed to provide services to industry was the industrial training program for the printing and related industries. Approximately 150 people from the printing and related industries came to Clemson to receive special training in short, non-credit, individualized training sessions.

The faculty served as consultants to school districts, technical colleges and the State Department of Education as well as to industry, professional organizations and other universities. The level and the frequency of faculty involvement in public service activities have increased during the past year.

Several proposals for research funding developed by the faculty during the year are pending. Five training grant proposals were funded during the year, and three are expected to be funded again next year.

New equipment was purchased to update the industrial technology education laboratories in computer-aided machining, robotics and computer-aided drafting.



## **In-Service**

Clemson continues in its position as a leader among South Carolina institutions in providing support services for local school districts, teacher organizations, teachers, administrators and industries. Graduate classes are offered on an evening schedule to accommodate the needs of teachers and administrators employed in area schools. In addition, special institute courses for graduate credit are designed and taught in off-campus locations throughout the state to meet unique needs of school districts.

During 1988-89 the College of Education offered 186 off-campus courses at 40 locations throughout the state for 2,793 students. Of those courses, 96 were regular Clemson University courses offered at 17 different locations for 1,100 students. In addition, 90 contract courses were held at 27 sites and enrolled another 1,693 students. The contract courses included 37 that were funded by the State Department of Education as critical teacher needs (CTN) courses in mathematics, reading, sciences and computer education for 645 students. This represents an increase over 1987-88 of some 518 students and 31 additional courses.

## **Research, Grants and Related Activities**

In addition to continuing grants in science and mathematics education, drug education, the Clemson Writing Project and educational leadership, the College of Education initiated numerous efforts aimed at strengthening its services to the schools of the state. Included were activities with the State Department of Education, the Commission on Higher Education and a large number of state and regional agencies, professional organizations, and business and industry.

A summer administrators leadership conference assisted school administrators from across the state in determining the most effective leadership styles and their application. Additional seminars focusing on effective school research practices were held during the year for practicing school personnel as part of a grant from the State Department of Education.

Other grants and research-oriented activities included a program funded by the State Department of Education to prepare teachers of infants and preschoolers with handicaps, a number of small grants to support the ongoing retraining of teachers in industrial technology education, principles of technology, applied vocational mathematics and vocational education, and a number of other programs aimed at preparation of new teachers for vocational subjects as well as continuation of trade and industrial teacher education programs offered on a statewide basis.

The Office of Extension Services and Placement held its second annual Clemson University Teacher Interview Program (CUTIP), with more than 100 school personnel from systems in four states participating. During the two-day event hundreds of interviews were held for prospective teachers.

Army and Air Force ROTC programs provided \$454,000 in academic aid for 86 Clemson students. In the Air Force ROTC program, approximately \$190,000 went to 44 scholarship holders; the student organization for the AFROTC unit, the Arnold Air Society, won second place in the annual Best in the Nation competition. In the Army ROTC program approximately \$264,000 went to 45 scholarship holders. The recently



established Army ROTC Endowment Fund will provide room and board for four-year scholarship winners. In addition, the Army ROTC's Society of American Military Engineers (SAME) was recognized as Best in the Nation in national competition, bringing honors to the students enrolled as well as the faculty and staff of the unit.

## COLLEGE OF ENGINEERING

During this Centennial year the College of Engineering has reviewed again Thomas Green Clemson's will. In this document he states his desire to establish a college that would provide useful information to farmers and mechanics through instruction in agriculture, the mechanic arts and the natural sciences, combined with physical and intellectual education. The College of Engineering looks back with great pride to the impressive strides made in one hundred years of instruction, research and service to South Carolina and the nation. At the same time the college looks forward to greater challenges and contributions for the second century, always building on Thomas Clemson's desire to develop the intellectual as well as the material resources of the state.

During fiscal year 1988-89 the S.C. Legislature approved bonds for the development of a new building for the college. Additional space is necessary to continue expansion of teaching and research efforts into the next century.

In 1988-89 undergraduate and graduate enrollment remained high. Total undergraduate enrollment for fall 1988 was 3,021, and graduate enrollment was 564 (410 in engineering master's programs and 154 in doctoral programs). These totals include agricultural engineering, which is jointly administered by the College of Engineering and the College of Agricultural Sciences.

The number of freshman engineering applicants was 1,685, with average SAT scores of 1,089. The percentage of freshmen who ranked in the 80th percentile of their high school class was 67.4. Thus, Clemson engineering continues to attract top students, both nationally and internationally, in all of its programs.

The college has implemented aggressive new programs designed to attract minorities to engineering at Clemson and to keep them enrolled in their majors until graduation. This is an issue of great national concern. These programs are discussed in the "Instruction" section of this report.

Research in the college remains at record high levels. The addition of a new building by 1992 will enhance research opportunities for faculty and students by allowing more laboratories and new equipment. Teaching and office space will also be greatly improved. Both faculty and students are committed to the development of new technology to help the United States keep pace with the world market in the 1990s and beyond.

The college had another record year in terms of gifts and grants received. The Department of Electrical and Computer Engineering received substantial support from Southern Bell, which donated \$250,000 for the establishment of a Telecommunications Laboratory. Also, a successful fund drive resulted in two \$500,000 professorships sponsored by Duke Power and in the establishment of the Duke Scholars Program. Mr. John T. Mundy of Mount Pleasant, S.C. (class of 1928), a retired executive of South



Carolina Electric and Gas Co., created a trust to provide graduate scholarships and fellowships.

The Engineering Graphics Program received a donation of \$54,186 from the National Science Foundation (NSF) to conduct a workshop on "Computer Graphics in Undergraduate Engineering Design." Twenty-four faculty members representing a cross section of national universities will come to Clemson for this one-week session. The representatives will be acquainted with the latest computer graphics technology and will be involved in discussions of issues related to design education. Professor Vera B. Anand is the project director of this workshop.

Other significant contributions to the college include the James A. (Shine) Milling Engineering Scholarship for entering freshmen, the Clyde V. and Mamie Madren Scholarships in Civil Engineering, the John A. and Evelyn H. Wells Scholarships in Ceramics and the James Roy Carter Jr. Endowed Presidential Scholarship Fund.

The College of Engineering has undergone some faculty and administrative personnel changes during 1988-89. Dr. Jonathan Black was appointed to the Hunter Endowed Chair in Bioengineering. This chair, made possible through a deferred gift of \$1 million from alumnus Thomas M. Hunter (class of 1909) in 1987-88, is the first chair in the world to be devoted to biomaterials engineering and science. Mrs. Page Hunter contributed additional funds to the Hunter Chair as well as to the University's fund drive to build a biomedical and bioengineering research facility. Dr. Black is an internationally renowned scholar in orthopaedic biomaterials. His research deals with the fundamental questions of the interactions of living cells and biomaterials and with applied solutions to orthopaedic problems. The author of more than 70 original research articles, six textbooks and five patents, he has won numerous research awards, including the Gold Medal of the British orthopedic Association and the Clemson Award of the Society of Biomaterials. Dr. Black has degrees in physics (B.S., Cornell), engineering science (M.S., Pennsylvania State University) and biomaterials (Ph.D., University of Pennsylvania).

Also established in 1987-88, the Dow Chemical Professorship in the Department of Chemical Engineering has been filled by Dr. Dan D. Edie, a Clemson faculty member, after a national search.

In other faculty appointments Dr. Gene H. Haertling joined the Department of Ceramic Engineering as the Bishop Distinguished Professor in January 1989. Before coming to Clemson Dr. Haertling held positions at the University of Missouri (Rolla), Motorola and Sandia National Laboratories. Dr. Haertling will expand the department's program in electro-ceramic materials, with special emphasis in superconductor devices, piezoelectric devices and electro-optic devices.

In the Department of Chemical Engineering Dr. James M. Haile returned to Clemson as of June 1, 1989. Dr. Haile has been at the University of Tulsa where he served as department head during the fall of 1988. Dr. Haile previously served on Clemson's Chemical Engineering faculty from 1976 through the summer of 1988. Also in Chemical Engineering, Dr. Douglas E. Hirt accepted a faculty position after completing his Ph.D. degree at Princeton University.

Four new faculty members will join the Electrical and Computer Engineering Department in the fall of 1989. Dr. Ronnie G. Owens, assistant professor, will join the



microelectronics area. Dr. Owens received his B.S. from Lamar University and his M.S. and Ph.D. degrees from Colorado State University. Dr. David Lubkeman, associate professor (B.S., M.S. and Ph.D. degrees, Purdue University), will join the power engineering area. Dr. Lubkeman was an assistant professor at North Carolina State University.

Another addition to power engineering is Dr. Randolph Collins Jr., assistant professor. Dr. Collins received his B.S. degree from North Carolina State University and his M.S. and Ph.D. degrees from the Georgia Institute of Technology. Finally, Dr. James E. Harriss, assistant professor (B.S., M.S. and Ph.D. degrees, Georgia Institute of Technology), will join the Electrical and Computer Engineering Department as a research associate. Dr. Harriss was previously employed with Rockwell International in Newport Beach, Calif., as a senior quality engineer in MOS semiconductor wafer manufacturing. Dr. Harriss will be working with the Microstructures Laboratory.

Dr. William G. Ferrell Jr. joined the Industrial Engineering Department as an assistant professor in August 1988. Dr. Ferrell is involved in advanced systems modeling, especially in the area of manufacturing quality. He holds a B.S. degree from Wake Forest University, an M.S.E. from Virginia Tech and a Ph.D. degree from North Carolina State University. Dr. Ferrell has had several years of industrial experience with Babcock and Wilcox.

In the Department of Mechanical Engineering Dr. John Riester has been appointed a visiting assistant professor working with the Macalloy Project. Effective in fall 1989 Dr. Riester will occupy a tenure-track position in the department.

Edward H. Vickers served as a visiting instructor in the Freshman Engineering Program for a one-year term. Mr. Vickers has an M.S. degree from Clemson's Department of Electrical and Computer Engineering.

Several faculty are on research leave. In the Department of Electrical and Computer Engineering Dr. Kelvin F. Poole, associate professor, will be on leave August 14, 1989, through December 14, 1989, to lecture at the University of Natal, South Africa. Dr. John D. Spragins, professor, will be on sabbatical leave August 15, 1989, through May 15, 1990, to conduct research and development work in computer communications at Hewlett Packard's European laboratories in Bristol, England. Dr. Yuan F. Zheng, associate professor, will be on leave August 15, 1989, through May 14, 1990, to teach and conduct research at Ohio State University.

Dr. Burtrand I. Lee, assistant professor in the Ceramic Engineering Department, will take a leave of absence from August 15, 1989, to December 15, 1989, to accept a Fulbright Scholar's Award at the Institute of Inorganic Chemistry at the University of Trondheim Norwegian Institute of Technology. Dr. Lee will collaborate in research on aluminum nitride materials for electronic substrates and superconductors and will advise a doctoral student on the use of fluoride glass for optical fibers.

Faculty members who have retired during the year include Dr. Jay W. Lathrop, who retired from the Electrical and Computer Engineering Department in December of 1988 after 20 years as a professor of semiconductor device reliability and VLSI integrated circuits.

Dr. F. Christopher Alley, director of Continuing Engineering Education and professor of chemical engineering, will retire effective September 30, 1989. Dr. Alley has been a member of the chemical engineering faculty since 1958.



Professor Stephen C. Clark, instructor in industrial engineering, retired May 16, 1989. Professor Clark served the college in the Engineering Technology and Industrial Engineering departments following his retirement from a distinguished career with Ingersoll Milling Machine Co. Dr. Clark was active in professional societies, particularly with the South Carolina Society of Professional Engineers, where he served as coordinator of the Mathcounts Program.

An Alumni Professor in the Civil Engineering Department, Jack C. McCormac, retired May 16, 1989, after 36 years at Clemson University. After graduating from the Citadel in 1948 and receiving his M.S. degree from Massachusetts Institute of Technology (MIT) in 1949, Professor McCormac spent two years teaching at Clemson before taking a job with E.I. DuPont Company. Four years later Professor McCormac returned to Clemson where he has been instructing civil engineering students for the past 34 years. In addition to his dedication to teaching, Professor McCormac's contributions to the profession are exceptional and include publication of seven widely adopted textbooks, some of which are now in advanced editions and have been translated into Spanish, Arabic, Portuguese, Chinese and Yugoslavian languages. More than 400 schools throughout the world are using one or more of Professor McCormac's textbooks, of which more than 500,000 copies have been sold.

Some important changes have taken place in the administrative area of the college. Dr. John N. Gowdy, professor, has been named interim head of the Electrical and Computer Engineering Department while a search for a permanent head continues. Dr. Gowdy succeeds Dr. A. Wayne Bennett, professor, who was named associate dean for research and external affairs for the College of Engineering in the fall of 1988. Dr. Bennett had been serving as interim associate dean since July 1988. Dr. Bennett oversees research, development and public information services in the college. He has been engaged in efforts to get alumni and industry more actively involved in the life of the engineering college. Dr. Bennett has also spearheaded new research and development efforts.

Dr. Russell H. Brown, professor and former interim associate dean for research and external affairs, returned to his post as head of the Department of Civil Engineering in July 1988.

Dr. Robert P. Davis resigned as head of the Industrial Engineering Department in May 1989. He will remain on the faculty as a professor in the department. Dr. Delbert L. Kimbler, associate professor, is acting department head of industrial engineering while a search is being conducted to fill this position.

Dr. William F. Beckwith, professor of chemical engineering, has been appointed director of freshman engineering and engineering graphics effective May 15, 1989. Dr. Beckwith was the acting director of freshman engineering during the past year.

## **Faculty Honors and Awards**

### **Faculty**

During fiscal year 1988-89 faculty have been honored with numerous awards in teaching, research and public and professional service. The diversity of these awards is indicative of the wide range of talents faculty members possess in their areas of expertise.



## Agricultural Engineering

- Dr. Tom Garner, professor, received the Outstanding Teacher of the Year Award from the Clemson Chapter of Gamma Sigma Delta. This award is given annually to the outstanding teacher in the Division of Agriculture and Natural Resources at Clemson University. Gamma Sigma Delta is a national honor society for agricultural scientists.
- Dr. Darrell Roberts, professor, received the Packer Engineering Safety Award for 1988 from the American Society of Agricultural Engineers. Dr. Roberts was recognized for his outstanding contributions in providing safety information regarding chain saws, all-terrain vehicles and wood-burning stoves. Dr. Roberts has worked to prevent farm machinery accidents and has developed a statewide school fire safety program.

## Bioengineering

- Dr. C.L. Vaughan, associate professor, was listed in *Who's Who in the South and Southwest*, *5,000 Personalities of the World* and *Who's Who in the Computer Industry*.
- Dr. Andreas F. von Recum, professor and head of bioengineering, has been elected secretary-treasurer of the Society for Biomaterials for a four-year term. He has also been appointed program chairman for the Biomaterials Society Meeting 1990 to be held in Charleston, S.C. This meeting attracts around 1,000 participants. An issue of the *Journal of Investigative Surgery* has been dedicated to Dr. von Recum in recognition of his leadership in the society and for his contributions to the journal.
- Two members of the bioengineering faculty have been given leadership positions in professional organizations. Dr. Fertac Bilge, assistant professor, chaired the Seventh Southern Biomedical Engineering Conference held in Greenville, S.C. Dr. Dennis L. Powers was appointed to the editorial board of the *Journal of Investigative Surgery*, the publication of the Academy of Surgical Research.

## Ceramic Engineering

- Dr. Burtrand I. Lee, assistant professor, received a Fulbright Scholarship to study special ceramic materials at Trondheim, Norway, with the Institute for Inorganic Chemistry during the first half of the 1989-90 academic year.
- Dr. Gordon Lewis, professor and head, was appointed to a three-year term as a liaison between the Minerals, Metals and Materials Society (TMC) and the National Institute of Ceramic Engineers (NICE). NICE assumes responsibility for the Accreditation Board for Engineering and Technology's (ABET) interaction in ceramic engineering. TMC assumes the same responsibility in metallurgical, mining and materials engineering.



## Chemical Engineering

- Dr. William F. Beckwith, professor and director of freshman engineering, was elected chairman of the Chemical Engineering Division of the American Society for Engineering Education (ASEE).
- Dr. Dan D. Edie, professor, was an invited lecturer at a symposium on Carbon Fibers and Composites sponsored by the American Carbon Society at SUNY Buffalo, July 18-21, 1988. Dr. Edie authored "Mesophase and Pitch Fibers" in *Carbon Fibers and Filaments*, edited by J.L. Figueiredo and published by Kluwer Academic Publishers. He was also selected to serve on a study committee of the National Research Council to review high-performance fibers and their composites. Finally, Dr. Edie was an invited lecturer at the NATO Advanced Study Institute on Carbon Fibers and Filaments in Alvor, Portugal, May 15-27, 1989.
- Dr. Stephen S. Melsheimer, professor, was selected to chair the University's self-study steering committee for the Southern Association of Colleges and Schools.

## Civil Engineering

- Dr. Earl J. Hayter, associate professor, received the 1989 Byars Prize for Excellence in Teaching. This award recognizes outstanding undergraduate teaching in engineering mechanics in the College of Engineering.
- Dr. Paul B. Zielinski, professor of civil engineering and director of the South Carolina Water Resources Research Institute, will serve as president-elect of the National Association of Water Institute Directors (NAWID) for a second year before becoming president.

## Electrical and Computer Engineering

- Dr. Chalmers M. Butler, professor, serves as the vice-chairman of the U.S. National Committee of the International Union of Radio Science.
- Drs. Lewis T. Fitch (alumni professor) Robert W. Snelsire (associate professor), and David W. Tipper (assistant professor) received the NCR Outstanding Educator Awards for 1988. These awards are presented by NCR Corporation of Liberty, S.C. The professors were selected on the basis of evaluations from students in exit interviews after graduation. The recipients shared a \$500 cash award.
- Dr. Lewis T. Fitch was nominated by Clemson University for the Governor's Professor of the Year Award in the fall of 1988. The award is jointly sponsored by the Commission on Higher Education and the Governor. The winner of the award will be announced in the fall of 1989.
- Dr. Adly A. Girgis, associate professor at Clemson, and Robert G. Brown of Ames, Iowa, were granted a patent, "Adaptive Kalman Filtering in Fault Classification," on March 14, 1989.
- Dr. John Y.S. Luh, McQueen-Quattlebaum Professor, serves as chairman of the technical committee on automation and robotics of the IEEE Control Society.



- Dr. Elham B. Makram, associate professor, received the 1988 IEEE/PES Award for outstanding contributions in the Continuing Education Subcommittee. Dr. Makram serves as secretary to the IEEE Continuing Education Subcommittee and to the IEEE Power Education Committee.

### **Environmental Systems Engineering**

- Dr. Benjamin Dysart, professor, was invited by Governor Carroll Campbell to serve on the newly created Governor's Freshwater Wetlands Forum. The Wetlands Forum is charged with the adoption of a comprehensive wetlands policy for the state of South Carolina by determining a single regulatory definition of wetlands, inventorying the state's wetlands, and determining how to protect wetlands. Dr. Dysart is chairman of one of the three task forces of this forum, which deals with scientific and policy issues. Dr. Dysart also was asked to join the Electric Power Research Institute's Advisory Council. He was appointed a member of the U.S. Army Chief of Engineer's Environmental Advisory Board for a two-year term and was elected secretary and a member of the executive committee of the Rene Dubos Center for Human Environments.
- Dr. Alan W. Elzerman, professor, was elected treasurer of the 4,000-member Division of Environmental Chemistry of the American Chemical Society.
- Dr. Robert A. Fjeld, associate professor, was elected to the board of the National Radon Association.
- Dr. C.P. Leslie Grady Jr., R.A. Bowen Professor, was the 1989 recipient of the Simon W. Freeze Award of the American Society of Civil Engineers. The award is presented annually to a professor for outstanding contributions to the field of environmental engineering.
- Dr. J. Charles Jennett, dean of engineering and professor of environmental systems engineering, was named one of the top 100 alumni from the College of Engineering at the University of New Mexico.
- Dr. Thomas M. Keinath, professor and head, was elected chairman of the U.S.A. National Committee for representation to the International Association on Water Pollution Research and Control. He was also elected vice-president of the Association of Environmental Engineering Professors and was appointed vice-chairman of the program committee of the Water Pollution Control Federation.

### **Industrial Engineering**

- Drs. Robert P. Davis (professor) and W.J. Kennedy (professor) were elected to the rank of Fellow in the Institute of Industrial Engineers. This is the highest rank in IIE and is awarded for outstanding achievement over a long term of service to the profession. Dr. Davis was also asked by the National Academy of Sciences to be a member of a committee of the Manufacturing Studies Board. This committee is sponsored by the National Science Foundation, and its objective is to provide advice regarding research directions and emphasis in design theory, methodology and education.



- Dr. Delbert L. Kimbler, associate professor, received the Manufacturing Systems Award from the Institute of Industrial Engineers (IIE) for service and achievement in manufacturing. He is also serving as president of the Society for Integrated Manufacturing of IIE.
- Dr. Bevlee A. Watford, assistant professor, received the 1989 Young Educator of the Year Award from the Piedmont Chapter of the South Carolina Society of Professional Engineers. This award is based on outstanding contributions made by Dr. Watford during the early years of her teaching career. In June 1989 Dr. Watford was also recognized as the Young Engineer of the Year by the S.C. Society of Professional Engineers, one of the highest honors a young engineer can receive.

### **Mechanical Engineering**

- Dr. Donald E. Beasley, associate professor, was recognized for his outstanding classroom teaching by the Clemson Pi Tau Sigma Chapter as the second recipient of the Eugene H. Bishop Award.
- Dr. Eugene H. Bishop, professor, was selected as the Clemson University nominee for the Governor's Professor of the Year Award in June 1989. The award is jointly sponsored by the Commission on Higher Education and the Governor. The winner of the award will be announced in the fall of 1989.
- Dr. James G. Goree, professor, was invited to present a paper at the first U.S.S.R.-U.S.A. Symposium on the Mechanics of Composite Materials. The conference was held in Riga, Latvian SSR, in May 1989 as a direct result of an agreement signed between the American Society of Mechanical Engineers and the U.S.S.R. Academy of Sciences.
- Dr. Cecil O. Huey Jr., professor, received the 1989 Engineering Educator of the Year Award from the Piedmont Chapter of the S.C. Society of Professional Engineers. This award recognizes distinguished contributions to engineering education, especially in the classroom.
- Dr. Frank W. Paul, McQueen-Quattlebaum Professor, and Joey K. Parker, former Ph.D student, were recipients of a U.S. patent, "Method and Apparatus for Controlling Impact Force During Rapid Robotic Acquisition of Objects" (U.S. patent number 4,783,107).
- Dr. Christian E.G. Przirembel, professor and head, was elected a Fellow of the American Association for the Advancement of Science. He was cited for "his innovative leadership in mechanical engineering education and outstanding research in separated flow." Dr. Przirembel was also elected to the executive committee of the Board of Directors of ABET. Additionally, he chaired the American Society of Mechanical Engineers (ASME) 1989 Mechanical Engineering Department Heads' Conference on the future of mechanical engineering education.
- Dr. Henry J. Rack, professor, was elected a Fellow of ASM International for distinguished contributions in the field of materials. Dr. Rack was also appointed to the international advisory committee for the seventh CIMTEC-World Ceramics Congress.



In the Department of Mechanical Engineering several professors received professional society appointments:

- Dr. Larry P. Golan, associate professor and director of the South Carolina Energy Research and Development Center, was elected director of the AIChE Heat Transfer Division and chairs the API committee on sampling projects.
- Dr. John E. Jackson, associate professor, was elected associate editor of the ASME *Journal of Materials Technology*.
- Dr. E. Harry Law, professor, serves as associate editor of the ASME *Journal of Dynamic Systems, Measurement and Control*.
- Dr. Henry J. Rack, professor, was elected secretary of the ASM/AIME Composites Committee and also selected to serve on the ASM National Nominating Committee.

### **Student Awards and Recognition**

This past year several students in the College of Engineering received honors and recognition at regional and national levels, as well as at the University level. A partial list of these exemplary students follows.

#### **Ceramic Engineering**

- Darren Rogers (B.S. Ceramic Engineering, 1989, Summa cum laude) successfully competed for a DOE/Battelle Graduate Research Fellowship to support his Ph.D. research work at Clemson for the next three years. He is working under the direction of Dr. C.C. Fain on carbon fiber processing.
- Kristen Schwind (B.S. Ceramic Engineering, 1989, Summa cum laude, senior departmental honors) also successfully competed for a DOE/Battelle Graduate Research Fellowship to support her next three years of doctoral study at Clemson. She is working under the direction of Dr. H.D. Leigh, III, on high-strength ceramic materials.
- Nettie Sweet (senior in ceramic engineering) was awarded a scholarship for her senior year at Clemson from the South Carolina Consulting Engineers. She prepared a paper on consulting engineers that won a statewide competition.

#### **Chemical Engineering**

- Clemson's student chapter of AIChE received the National Outstanding Chapter Award, which it has won seven of the last 10 years. Additionally, it was voted best chapter in the Southeast.

#### **Civil Engineering**

- Seniors Phylliss Kohl, F. Scott Sprouse and David B. Lambert received R.C. Edwards Fellowships to pursue graduate study in civil engineering at Clemson.
- Todd Stevens won second place in a student paper presentation at the Carolinas Conference of the American Society of Civil Engineers for his paper, "The Future of Transportation."



- Scott Walkowicz, a junior from Detroit, Mich., received a \$1,000 scholarship from the Carolinas Chapter of American Concrete Institute.
- Allen B. Ward, a junior from Walterboro, S.C., received the \$300 annual scholarship from the South Carolina Society of Professional Land Surveyors.

### **Electrical and Computer Engineering**

- Nancy Lynne Cronin received the Robert W. Moorman Award for Outstanding Junior.
- Scott McMillan received the Samuel B. Earle Award for Outstanding Senior.
- Mark D. Hanes, Nancy B. Heilemann and Alene C. Weber were selected to receive DuPont Graduate Fellowships. Twenty candidates were selected by an independent panel of educational advisers to receive \$4,000 per year stipends to pursue graduate degrees in electrical engineering at consortium schools. Clemson was the only school to have three fellowship recipients in electrical and computer engineering.

### **Environmental Systems Engineering**

- Meredith Neuman, graduate student working with Dr. Alan Elzerman, has been named a winner of the Graduate Student Paper Award given by the Division of Environmental Chemistry of the American Chemical Society. The paper will be presented at the national meeting in Miami, Fla., in September 1989.

### **Industrial Engineering**

- Christine Lynne Sherman was awarded the Phi Kappa Phi Certificate of Merit.
- Sharon Helena Tyson received the J. Wesley Davis Leadership Award.
- The Clemson Chapter of the Institute of Industrial Engineers received its fourth consecutive Award of Excellence. This award is part of a national competition and is presented to a chapter because of the breadth and quality of the student professional activities.
- A local chapter of Alpha Pi Mu, the Industrial Engineering Honor Society, was formed and chartered by the national organization this past spring. Several Clemson students were initiated into the society, as was Dr. James A. Chisman, a faculty member, in a ceremony conducted by the University of Tennessee Chapter.

### **Mechanical Engineering**

- John Eric Bowman received the Tau Beta Pi Award for Outstanding Sophomore.
- Senior Christopher J. Constantine won second place in the 1989 ASME Region IV Old Guard Technical Paper Competition with his paper, "A Study of the Lateral Stability of Four Wheel Steering Tractor Trailer Combination."
- Graduate student John A. Pinson was selected for a DuPont Fellowship to pursue a master's degree in the Department of Mechanical Engineering at Clemson



University, and was subsequently selected for a DuPont Teaching Fellowship to support his Ph.D. studies at Pennsylvania State University beginning in the fall of 1989.

- Senior David E. Rhodes won third place in the 1989 ASME Region IV Old Guard Technical Paper Competition with his paper, "Variable Compression Ratio Diesel Engines," which was also recognized as having the highest technical content.
- Senior Richard L. Waltermann was selected in a national competition for an NSF Fellowship to pursue graduate work in the Department of Mechanical Engineering at Clemson.

## Instruction

Clemson's College of Engineering is one of the largest academic units on campus in terms of enrollment and degrees granted. Total enrollment for fall 1988 was 3,585. Out of this total, 3,021 were undergraduate students and 564 were enrolled in graduate programs. There were 410 students enrolled in engineering master's programs and 154 in Ph.D. programs. Between July 1, 1988, and June 30, 1989, the College of Engineering awarded 462 baccalaureate degrees, 146 master's degrees and 17 doctoral degrees.

The departments and research centers within the College of Engineering are constantly expanding and revising their instructional programs to meet the needs of an ever-changing technological marketplace. Several collegewide programs have been implemented to address the needs of specific student groups enrolled in engineering.

The Department of Agricultural Engineering has made significant changes in its undergraduate curriculum during 1988, the most significant in the history of the department. Students now have the option of choosing an emphasis in one of four areas: biotechnology engineering, food engineering, natural resources engineering, or agricultural production and consumer products. A comprehensive plan has been implemented to inform potential students and agencies who employ our graduates of these new areas of emphasis.

In the Ceramic Engineering Department Dr. T.D. Taylor received a third renewal of a grant from the U.S. Research Association to continue developing and presenting an undergraduate class in space manufacturing design.

In the Engineering Graphics Program, an 800-level graduate graphics course was taught for the first time this past spring semester. Computer-Aided Geometric Modeling was developed and taught by Professor Nadim Aziz.

The Department of Industrial Engineering received its initial accreditation from ABET. This was a major milestone in the growth of the department, which began operation with only a small nucleus of faculty and students in 1983. The department's PARAprrofessional TEChnical (PARATEC) Field Project Program continues to provide challenging and practical engineering experiences for students.

The projects in this industrial engineering program are conducted in local industries. In addition to enhancing students' education through professional practice and experience, this program provides a valuable engineering resource to participating companies. More than 50 companies participated in almost 300 projects in the past year.



The faculty of the Department of Mechanical Engineering spent the year reviewing and modifying its undergraduate curriculum to keep up with current trends in the profession. Areas of particular concern included the overall engineering design component of the curriculum, which resulted in the introduction of a thermal/fluid science design course; the integration of materials engineering, engineering design and manufacturing; an expansion of the nationally recognized senior project course; and a technical communications component. On the graduate level the department had six Ph.D. graduates, the largest number in the history of mechanical engineering at Clemson.

The collegewide Freshman Engineering Program continues to add programs to help first-year engineering students make the transition from high school to college and to help them choose an engineering major.

This program continues to enroll the largest number of students of any department on campus. Enrollment is almost 1,400 students, with more than 900 students entering the program at the start of the fall semester. A second counselor has been added to advise all of these students. Thus, Freshman Engineering currently has two counselors and two faculty members, with one faculty position open. The number of students seeking the help of the faculty and counselors continues to increase, which is a sign that the program is fulfilling its mission.

An attractive feature of the Freshman Engineering Program is that it is designed to allow new students one year at Clemson before having to choose a specific degree program. Students are exposed to all engineering disciplines and have the opportunity to remedy any academic deficiencies before going into the advanced courses. Students who decide not to pursue engineering may transfer from freshman engineering to any other major at Clemson without losing course credits.

The Minority Engineering Program marked its twelfth year of operation in 1988-89. Under the direction of Dr. Robert W. Snelsire, associate professor of electrical and computer engineering, the program consists of three parts: the Clemson Career Workshop (a pre-college summer program), the Industrial Associates Scholarships for minority students enrolled in engineering, and the newest facet of the program, PEER (Program for Engineering Enrichment and Retention), a peer-mentoring program designed to help freshman and sophomore minority engineering students.

PEER, a program whose goal is increased retention of students, is having dramatic success. Fully 73 percent of the black freshmen enrolled in engineering at Clemson in the fall of 1987 continued on into their sophomore year in engineering. This retention rate is impressive by national standards.

Clemson is addressing the national demand for more minority engineers by increasing the number of minority students enrolled. A large pool of qualified applicants enabled the College of Engineering to raise black enrollment by 20 percent. Projections indicate another 20 percent increase for the year 1989-90.

In 1988-89 the College of Engineering received scholarship funding from the National Action Council for Minorities in Engineering (NACME) for the fourth consecutive year.

Institutions selected to receive this funding are chosen on the basis of minority enrollment in engineering. Funding is provided for the student throughout his/her program of study when acceptable academic progress is shown. Clemson has participated in the Incentive Grants Program of NACME since 1985, owing to the increasing minority population in the College of Engineering.



## **Research**

During its Centennial year Clemson University has continued its growth as a leader in engineering research among universities within the state and across the nation. The essential goals of engineering research at Clemson have remained constant through the years: to seek new knowledge; to seek solutions to both the short and long-term technological problems of the state and nation; and to support advanced-level educational programs by providing significant research experiences for students.

Clemson engineering generally attracts a greater percentage of research funds from industry than do engineering schools at other universities. The dollar amount of contracts and grants has increased each year for the past five years, with a record-breaking \$12 million of funded grants and contracts-in-force in 1988-89. Contracts and grants awarded were \$6 million in the fiscal year 1988-89. During this past year 114 faculty were engaged in research supported by 301 graduate students, 109 undergraduates and 27 staff members (temporary and permanent) and visiting scholars.

### **Departmental Research Highlights**

In the Bioengineering Department the Biomedical and Bioengineering Research and Development Facility received funding from the state in the summer of 1988. The BioFact Development Campaign continued to raise supplementary funds for the construction of this facility, which should be operational in 1991. The BioFact building committee has completed program planning, and architectural and engineering design work has begun. This facility will provide a home for sophisticated biomedical, bioengineering and life sciences research and will include laboratories and facilities for animal housing and care.

In the Department of Chemical Engineering the total level of funded research exceeded \$1,320,000 this year — a “first” for the department. Chemical Engineering has maintained a pattern of growth in research funding of better than a 35 percent increase each year over the last eight years. This impressive performance has been accomplished while the department has sustained nearly half of this support from industry. A major research thrust of the department was endorsed this year when the S.C. Commission on Higher Education authorized the establishment of the Center for Advanced Engineering Fibers and Their Composites, which draws its membership from throughout the College of Engineering and the School of Textiles.

In the Electrical and Computer Engineering Department the Microstructures Laboratory was dedicated November 4, 1988. Dr. Jack Kilby, inventor of the integrated circuit, was the guest speaker. Located in the basement of Riggs Hall, the Microstructures Laboratory allows engineering students to learn about integrated circuits (computer chips) through hands-on experience.

The laboratory boasts a class-100 cleanroom with special air filters that allow students and faculty to work in a space where there are fewer than 100 particles, measuring greater than half a micron per cubic foot. Students using the laboratory will fabricate integrated circuits and run practical tests. The cleanroom is one of the few in operation in the United States. The Microstructures Laboratory, a teaching and research facility, will expand the scope of Clemson's Center for Semiconductor Device Reliability Research.



The 1988-89 year was an extremely successful year for the Department of Mechanical Engineering in terms of research. Grants/contracts-in-force exceeded \$3 million. Large grants were received from the Defense Logistics Agency and the General Electric Company/Department of Energy. New Awards totaled nearly \$2 million.

### **Major Equipment Gifts to the College**

The College of Engineering received major equipment donations from corporations and industry in 1988-89. Gifts of this kind enable the college to provide state-of-the-art teaching and research facilities for students and faculty. Some of these equipment gifts are listed below.

#### **Ceramic Engineering**

- Horiba Instruments donated a new \$27,500 CAPA 700 particle size analyzer to support a short course (characterization lab) directed by Dr. H.D. Leigh, III.
- Leeds and Northrup donated a \$39,999 Microtrac Fine Particle Analyzer for the characterization laboratory being established.
- Owens-Corning Fiberglas donated an X-ray fluorescence unit to support the work of Dr. H.D. Leigh, III.
- Sonics and Materials, Inc., donated a \$2,400 ultrasonic dispersion probe to Dr. D.R. Dinger to support his work in particle processing and packing.

#### **Civil Engineering**

- Duke Power Co. donated two GPM pumps valued at \$4,900 and five Morris pumps valued at \$50,000 for use by Dr. Ben Sill at the Clemson Hydraulics Laboratory.

#### **Electrical and Computer Engineering**

- Parametrics donated a \$4,000 microprocessor-based variable frequency control unit for the study of computer control of AC machines using RS232 port to interface with IBM PC and other equipment.
- Techni-Reps, Inc., donated a \$4,000 ASEA Brown Boveri variable frequency control for the power research area.
- Tektronix donated ten Sec/Div switches, valued at \$700, for classroom 2215 scope use.

#### **Environmental Systems Engineering**

- Duke Power Company donated \$103,258 in air pollution sampling equipment.
- The Self Foundation contributed \$300,000 to support a biotechnology laboratory for use by researchers from all over campus. Engineers and scientists in Environmental Systems Engineering will use the equipment in their work in environmental biotechnology.
- Sirrine Environmental donated a Perkin-Elmer model 303 Atomic Absorption Spectrometer valued at \$4,000 for the Greenwood Metro project.



- The Westinghouse-Spartanburg Nuclear Service Center donated a Canberra Series 40 multi-channel pulse height analyzer and Frontier Enterprises aerosol detection equipment valued at \$17,500.

### **Industrial Engineering**

- Dr. James A. Chisman donated a Quasar VK100 camera and a microcomputer modem for use with the motion and time study laboratories. The value is \$444.
- DatamYTE Corporation donated manufacturing quality data collection and analysis equipment valued at \$19,271.
- A grant from the NSF is adding computer equipment and workstations valued at \$76,000 to industrial engineering research laboratories. This grant is also providing hardware that will link faculty offices and labs to the college network through Ethernet.

### **Mechanical Engineering**

- The DuPont Co. donated a TAZ-Plus analyzer worth \$100,000.

### **Research Centers**

Clemson's College of Engineering is establishing its position as a major research institution through the development of its research centers of excellence: Center for Semiconductor Device Reliability Research, Center for Advanced Manufacturing, Center for Computer Communications Systems, Center for Engineering Ceramic Materials and South Carolina Energy Research and Development Center. The S.C. Commission on Higher Education authorized the establishment of the Center for Advanced Engineering Fibers and Their Composites, to be used jointly by the College of Engineering and the School of Textiles.

Each of these centers emphasizes a particular area of research, supported by faculty with recognized expertise in that area. This section deals with updates on these research centers, as well as other centers in which engineering faculty members play integral roles.

Dr. Richard Spray, professor of agricultural engineering, serves as director of the Clemson University Housing Institute (CUHI). This multi-disciplinary unit includes representatives from the colleges of Engineering, Architecture, Forest and Recreation Resources, Nursing and Agricultural Sciences as well as South Carolina State College. A competitive grant process made funds available for research and extension projects.

The Center for Engineering Ceramic Manufacturing received contributions from industry and trade organizations totaling more than \$87,000. The funds support the structural clay research work of Dr. G.C. Robinson and his students.

During 1988-89 the S.C. Energy Research and Development Center, a state agency administered by the University, funded 15 projects at the University of South Carolina and Clemson University. During the past two fiscal years the center's principal investigators have attracted \$1,190,785 in proposal awards from national sources and in industrial support.

The Center for Advanced Manufacturing had a productive research year. The center operates on funding from the Mechanical Engineering Department given to the director



of the center, Dr. Frank W. Paul, and on research contract-generated income. Special activities of the center this past year included its annual industrial research review meeting in April 1989 and sponsorship of the Hans Warneke Televideo conference attended by 45 industrial representatives.

The center industrial members and affiliates increased to seven participants, including companies such as Hoechst-Celanese, Reliance Electric, Rust International, Digital Equipment, Ingersoll-Rand and Ryobi. Several of these industries are participating in a consortium to address the rapid prototyping of mechanical components through the use of CAD-based sterolithography equipment operated by the Bioengineering and Mechanical Engineering departments. Grant income from the industrial participants increased to approximately \$280,000 in 1988-89 from \$109,000 in 1987-88.

Contract research funding has approximately doubled to \$1,500,000. This significant increase was owing to contract awards for the Ferrochromium Plasma Arc System, Robot Assisted Material Handling for Apparel Manufacturing and the Southeastern Manufacturing Technology Center.

The center is approaching its goal of \$2,000,000 of grant and contract awards in force. This has been accomplished through internal funding by the Mechanical Engineering Department and support of indirect cost returns to the center from the University administration.

### **Specific Research Projects**

Departments within the College of Engineering are actively engaged in research projects throughout the year. The following list of selected projects illustrates the diversity of research efforts at Clemson.

The Agricultural Engineering Department was involved in several innovative research projects this past year. The Binational Agricultural Research and Development fund (joint U.S.-Israel) sponsored research to use X-ray techniques to detect split pits in peaches. Split pits can cause extensive spoilage in fresh peaches in a short time.

The tracking of nematicides in soil is important because of economic and environmental quality considerations. USDA-CSRS sponsored research in a peach orchard in Edgefield County to determine the movement of nematicides when applied through a trickle irrigation system. The Integrated Pest Management (IPM) program sponsored research on monitoring grain storage facilities to determine when conditions are favorable for insect infestation. If undetected, these conditions can lead to millions of dollars in losses to the state's agricultural industry.

Also in Agricultural Engineering, an expert system was developed for site assessment and design of municipal sludge land application systems. This will assist municipal personnel and consulting engineers in the proper design of land application systems so that the soil and water resources will not be contaminated.

Finally, a low-cost cotton picker was designed and developed for use under third-world conditions. The modifications consisted of adapting a commercially available mechanical cotton picker to a more narrow row spacing, and using the available power unit for other agricultural applications.

In the Ceramic Engineering Department a project on carbon matrix composites directed by Dr. C.C. Fain and a project on ceramic superconductors directed by Dr. H.D. Leigh, III received support from NASA.



In other Ceramic Engineering projects: Dr. B.I. Lee received support from NSF for the second year on a project to investigate the steric hindrance associated with organic materials on ceramic powder surfaces; Dr. H.D. Leigh received support from AT&T-Nassau Metals to investigate refractory corrosion; Dr. G.H. Haertling received funding from Motorola and Kodak to continue work on ceramic electronics and optoelectronic materials. Also, Dr. H.G. Lefort received funding from the Clemson University Housing Institute to investigate toughened improved clay roofing tile for residential use.

In the Department of Civil Engineering the S.C. Sea Grant Consortium funded a study to develop a Coastal Hazards Research and Advisory Program. The consortium also funded a numerical modeling study of wave and current-induced sediment transport in tidal inlets.

Duke Power Co. provided funds for a hydrologic study of the Catawba Lake to improve hydroelectric and thermal plant performance. The S.C. Department of Highways and Public Transportation (SCDHPT) sponsored a study to redesign catch basins for storm water drainage. SCDHPT also funded a pilot study to determine the feasibility of inventorying all of the non-truss bridges in the state and evaluating their historical importance.

Bendix Corp. funded a civil engineering study on the engineering properties of composite materials for space applications. Also, the Transportation Technology Service was funded again for 1989. This service provides training and technical information to local agencies in the area of transportation. The Governor's Highway Safety Office funded a statewide analysis of traffic accidents in South Carolina. This study focuses on the identification of traffic accident problems and trends in the state.

In the Environmental Systems Engineering Department research on the radon problem in South Carolina continued to be a major area of investigation. Efforts during the past year focused on implementation of a technique for measuring radon emission from the ground and on the compilation of a database of indoor radon concentrations by postal zip code. The object of these activities is to identify those areas where elevated indoor concentrations are likely to occur.

Another research project, funded in part by Carolina Power and Light Co., focused on the removal of radioactivity from waste oils, thus enabling separate disposal of the radioactive and nonradioactive components. During the past year two techniques were identified for reducing the concentration of Cobalt 60 in waste oils to very low levels.

Municipal solid waste disposal is a growing concern throughout the United States. The Department of Environmental Systems Engineering is conducting a comprehensive review of the state-of-the-art and regulatory challenges of solid waste management for the U.S. Army Construction Engineering Laboratory. The review is examining the economics and environmental impacts of landfilling, incineration, recycling and composting of municipal solid waste.

Leaks of gasoline and immiscible solvents from underground storage tanks and from accidental spills pose a serious threat to subsurface drinking water supplies. A study sponsored by the South Carolina Water Resources Research Institute is being conducted in Environmental Systems Engineering to evaluate the transport behavior of such contaminants in ground waters. The development of new technologies for removing immiscible contaminants from groundwater sites is the ultimate goal.



Duke Power continues to support a research project to evaluate and improve the performance of environmental protection systems as well as to assess the residual impact of off-site streams at the billion-dollar Bad Creek Hydroelectric Station. The project is contributing substantially to the improvements of methods for siting, designing, building and operating major energy production facilities in an environmentally acceptable manner.

A study of applications of artificial intelligence in manufacturing is part of the research being conducted by Dr. Beville A. Watford in the Department of Industrial Engineering. A recently completed project in computer simulation, sponsored by General Electric, involved a graduate intern working in the company's Greenville plant. A similar intern project in quality engineering with the Torrington Co. is being supervised by Dr. W.J. Kennedy.

Quality and design are receiving major emphasis in Industrial Engineering. Two projects deal with this emphasis. One is sponsored by the NSF with Dr. Robert P. Davis as the principal investigator, and another is sponsored by Ingersoll-Rand (Drs. Delbert L. Kimbler and Joel S. Greenstein, principal investigators). These projects and continuing unsponsored work focus on integration of quality and design into manufacturing processes.

The Department of Mechanical Engineering is pursuing a project, "Deformation Processing of High Temperature Metal Matrix Composites," to examine the deformation behavior of short fiber and particulate reinforced metal matrix composites during thermomechanical processing. A generalized plasticity model is being developed that will take into consideration material, thermal and boundary effects, and will be used to predict composite metal flow during elevated temperature processing. High temperature metal matrix composites have major applications in the National Aerospace Plane Program.

An experimental investigation of the fluid mechanics and heat transfer in the boundary layer undergoing transition flow over curved surfaces is under way in the department. A special test facility has been designed and built for this research. The results of this investigation will improve the rational design methods of flow around gas turbine blades and will permit more precise prediction of the thermal efficiency of gas turbines.

Mechanical engineers are also conducting experimental and analytical studies of flexible-linked robotic manipulators. Classical and modern design methods are being used to reduce the adverse effects of vibrations and flexure to improve the accuracy of robot arm motion. The results will allow more rapid and precise handling of parts in advanced manufacturing systems.

Clemson's Mechanical Engineering Department is part of a research team consisting of Massachusetts Institute of Technology (MIT) and Clemson faculty, the South Carolina Research Authority and the Macalloy Corp., which is investigating the application of state-of-the-art thermal plasma technology to the smelting of reactive metals. The first metal under consideration is ferrochromium, which is added to steel during production to promote hardness and resistance to heat, corrosion, wear and abrasion. The Macalloy Corp. is the only domestic commercial producer of ferrochromium.

A research and development program is under way to combine the existing coal gasification technology with industrial gas turbines. Of particular concern is the necessary



modification of gas turbines to operate efficiently with low-BTU gas. The project team consists of faculty members from the Department of Mechanical Engineering and technical staff members from General Electric and CRS-Sirrine. Also, the Mechanical Engineering Department in conjunction with the Department of Electrical and Computer Engineering is investigating the design fabrication and reliability of microstructures that have typical dimensions of around 100 micrometers (i.e., the diameter of a human hair). Specific objectives include the quantitative estimate of the static and dynamic stresses encountered during normal steady state operation, during transient operation and during possible abusive operation.

### **Books Published and Related Activities**

Clemson's engineering faculty continue to be actively engaged in the publication of informative texts on diverse topics. Many faculty members publish journal articles, conference proceedings and technical papers, and serve as editors or on editorial boards of professional journals. Some of the books published by faculty during 1988-89 as well as professors serving as editors of journals (who have not been previously mentioned) are listed.

Dr. C. L. Vaughan, associate professor of bioengineering, authored a book, *Biomechanics of Sport*, published by CRC Press of Boca Raton, Fla. Dr. Vaughan has a book in production at Human Kinetic Press, *A Dynamic Manual of Human Gait*. Also in the Department of Bioengineering, Dr. Jonathan Black, Hunter Endowed Professor of Biomaterials, wrote *Orthopaedic Biomaterials: Biomaterials in Orthopaedic Research and Practice*, published by Churchill-Livingstone.

In the Department of Electrical and Computer Engineering, Dr. Chalmers M. Bulter, professor, is associate editor of *Electromagnetics* and serves on the editorial board of *Applied Computational Electromagnetics*. Dr. Adly A. Girgis, associate professor, recently published *Professional Engineering Exam Review Course: Automatic Control Systems* by the North Carolina State University Press.

Dr. John Y.S. Luh, McQueen-Quattlebaum Professor, published a chapter in the book *Robotics and Manufacturing: Recent Trends in Research, Education and Applications*, edited by M. Jamshidi, J.Y.S. Luh, H. Seraji and G.P. Starr. This work was published by the ASME Press. Dr. Luh is also an associate editor of the *IEEE Transactions on Robotics and Automation*.

Dr. Robert J. Schalkoff, associate professor, serves as associate editor of *Image and Vision Computing* and has completed a book, *Artificial Intelligence: An Engineering Approach*, to be published by McGraw-Hill in 1990.

Dr. William F. Beckwith, professor of chemical engineering and director of the Freshman Engineering Program, has written a manual for use in the freshman engineering course Engineering 180, Computers in Engineering. The manual, *Computers in Engineering Manual*, is published by Kendall/Hunt Publishing Company.

### **Public Service**

Continuing Engineering Education (CEE) is the primary public service activity of the College of Engineering. In an era of increasing foreign competition and techno-



logical change, practicing engineers must continue their education to remain competitive. CEE provides a program of seminars, short courses and workshops designed to make the most effective use of the time that industry can allot to technical training. CEE also develops and sponsors two- and three-day conferences that promote technology transfer in a number of emerging technology areas. A summary of the 1988-89 program is shown in the table below.

Type of Offering	Number	Program-Days of Effort	Attendance
Seminars, Workshops, Short Courses	41	79	732
Major Conferences	11	30	811
EIT/PE Reviews	162	162	3,212
In-House Seminars (for Industry)	12	15	275
TOTALS	226	286	5,030

Major conferences were sponsored in the areas of biotechnology, advanced engineering fibers, environmental control, the impact of mining on the environment, effective technical communications, and biomedical engineering. CEE also sponsored the Annual S.C. Highway Conference.

CEE offered programs in fifteen different states during the year. These programs included a one-day short course on quality control for architectural and engineering firms that was offered both as a public program and at two company locations; a three-day course on heating and air-conditioning design that was offered publicly in five states; and a two-day course on engineering project management that was offered twice for a major chemical company in Pennsylvania.

The number of engineers attending various courses in the CEE Professional Engineering (PE) Review Series increased 50 percent this year to a total attendance of 3,212. The series was offered in-house for Duke Power at both Charlotte, N.C., and the Oconee Nuclear Station in South Carolina.

The PE Review Series was also offered in Greenville, S.C., in cooperation with the Piedmont Section of the National Society for Professional Engineers (NSPE). This year the series, sponsored by NSPE, was also made available at minimal cost to those engineers who had already been registered for several years, but who wished to be updated on new developments in their fields.

CEE worked with faculty from the Clemson Food Science Department and furnished logistic support for a two-week course in food packaging for 15 students from Central and South America. Other inter-college activities included a one-day conference on mining co-sponsored with the College of Sciences, and a two-day biotechnology conference co-sponsored with the Department of Microbiology.

New programs offered during 1988-89 include a two-day course on Economic Evaluation of Engineered Projects, a two-day course on Programmable Logic Controllers, a two-day course on Fuel Combustion and Kiln Control, a one-day course on A/E Quality Control, and a two-day conference on Effective Technical Communication. All will be offered again during 1989-90.



## COLLEGE OF FOREST AND RECREATION RESOURCES

The report of 1988-89 activities for the College of Forest and Recreation Resources' resident instruction, research and Extension programs is included under the Division of Agriculture and Natural Resources on page 128.

## COLLEGE OF LIBERAL ARTS

It has been said that no university will ever become a great institution of higher learning without a strong program in the arts, humanities and social sciences. The College of Liberal Arts, having just completed its twentieth year as an independent academic unit at Clemson, continues to recognize the validity of this observation. In addition, it subscribes to the notion that a self-governing society requires of its citizens a basic and general education that will enable them, regardless of the career paths they follow, to lead full and thus useful lives, and to contribute to the general welfare of society.

Twelve percent of the undergraduates at the University major in the liberal arts, up from seven percent just six years ago; the faculty of the college teach approximately one quarter of the credit hours taken by students; and the college offers a number of the courses that fulfill the "general education requirements" of the University.

The College of Liberal Arts consists of the departments of English, History, Languages, Performing Arts, Philosophy and Religion, Political Science, Psychology and Sociology. Except for Performing Arts, all departments offer majors leading to the Bachelor of Arts degree. English and History offer the Master of Arts degree, while Psychology offers the Master of Science degree in Applied Psychology.

More than 90 percent of the tenured and tenure-track Liberal Arts faculty hold the doctoral or other terminal degree. Graduates of the college enter some of the outstanding graduate and professional schools in the country, and many of them pursue careers in business (including the service industries), industry and government upon taking their degrees from the University.

### Faculty Highlights

Three highly respected journals emanate from the College of Liberal Arts. *The South Carolina Review* is edited and published by faculty members in the Department of English. This distinguished magazine provides a forum for literary scholarship and criticism, as well as for outstanding poetry and short stories. The *Journal of Political Science*, with an international editorial board under the leadership of a faculty member in the Department of Political Science, boasts a list of authors from leading colleges and universities from this country and from overseas. This journal emphasizes the scholarly contributions of younger researchers and addresses contemporary themes, evidenced by an issue this year devoted to "Women in American Politics." The Department of Languages edits and publishes *The Comparatist*, which is devoted to the literary and language interests of scholars in the Southeast and which is the official publication of the Southern Comparative Literature Association.



Liberal Arts faculty also continue to be active in scholarly and creative endeavors. They deliver papers at regional, national, and international meetings and conferences; they contribute articles, poetry and fiction to a variety of established and influential journals; they edit book-length collections and prepare textbooks; they are active in musical and dramatic performances; and they write books in their areas of expertise that are issued by respected publishers and that receive favorable notices in the press. A book authored by a faculty member in the Department of English was selected as one of the five finalists in the non-fiction category for the highly prestigious National Book Award. In response to this accomplishment, he was named this year's recipient of the Alumni Research Achievement Award. A faculty member in the Department of Performing Arts secured roles in three nationally televised programs.

In addition and as further acknowledgment of the recognition faculty members in the College of Liberal Arts are receiving, they now often hold positions as officers and as board members of a number of professional organizations and societies. For example, a Political Science faculty member is vice chairman of the United States Board of Foreign Scholarships, while a Performing Arts faculty member holds the same position in the American College Theatre Festival. Too, the faculty serve on editorial boards of journals in their areas, as manuscript referees for publishers, and as evaluators of grant proposals.

Other departmental activities include, but are not limited to, the following: a book review service originating in the Department of English that specializes in children's books; research conducted by the Department of Psychology in topics such as aging, laterality of brain function, stress management, computer-assisted instruction, artificial intelligence, consumer behavior, decision-making strategies, the development of pattern vision in children, eating disorders and substance abuse; and research conducted by faculty in the Department of Sociology encompassing several areas including the police system, police-community relations, parental grief, child abuse, children's responses to crises, alcohol consumption, abortion, families in poverty and strategies used by employed spouses.

Regular features of the College of Liberal Arts include gatherings of scholars and creative writers. For example, the college often holds programs in cooperation with the Strom Thurmond Institute of Government and Public Affairs. This year the college continued the Women's Studies Colloquia, sponsoring three lectures and a two-day workshop for interested faculty. As a result of the planning done this year by one of its faculty, the Department of Philosophy and Religion has been selected to host a six-week National Endowment for the Humanities Summer Institute in 1990. The Department of English hosts, in conjunction with the College of Architecture, the Southern Circuit Film Series, which brings filmmakers to the campus.

A Psychology faculty member was this year's recipient of the Alumni Master Teacher Award. Two other faculty, one in English and the other in Philosophy and Religion, received respectively a Senior Fulbright Lectureship in Austria and a Fulbright Research Award to the Netherlands.



## Public Service

The public service roles played by the College of Liberal Arts throughout the state and region continue to experience significant growth. Political Science faculty are frequently called upon by units of local and state government, as well as by business and industry, for advice on poll-taking, taxation and governmental organization. In addition, political scientists serve frequently as panelists for civic organizations and consultants to both the print and electronic media on national and international affairs.

Sociologists contribute their expertise in the design and analysis of social surveys, leadership, the impact of industrial development on society, as well as in program development and evaluation in the fields of prison reform, spouse abuse, child custody, mental health, and alcohol and drug problems. Faculty in Sociology also offer workshops in staff growth and development for both private and public service agencies. For example, one faculty member conducts workshops in leadership in conjunction with a training contract awarded by the South Carolina Department of Social Services. Psychologists serve as consultants to the Southeastern Managers Network, an information sharing organization of senior managers representing more than 20 area businesses and industrial concerns. Psychologists also provide consultation on jury selection, eyewitness validation and expert witnesses on criminal sanity, survey studies for local and state agencies, and a weekly column on labor relations. English faculty work with business and industry by conducting seminars and workshops in business and technical writing.

In addition to offering a traditional language program, the Department of Languages emphasizes a practical, business orientation. Given the large foreign investment in South Carolina industry and the need to develop overseas trade markets, the department's language and international trade major represents an apt response. The department also sponsors an annual Language Declamation Contest, which drew more than 900 participants this year from South Carolina and nearby states. Languages also conducted 1989 summer study programs in France, Germany and Spain. Recognition of Clemson's language students came this spring when the national Fulbright Award Committee selected two students for scholarships to study for a year in Germany.

Among the continued recipients of the college's public service activities are the state's school teachers. Improved civic education in the state's public schools is the goal of the Thurmond Seminar, which is conducted by the Department of Political Science with funds from the Strom Thurmond Center for Government and Public Affairs. Twenty social science teachers from South Carolina's secondary schools participated in this summer's seminar, with classes held both in Clemson and Washington, D.C. Liberal Arts faculty held summer institutes on campus for Advanced Placement (AP) teachers in European and United States History, as well as in French and Spanish.

Together with the College of Education, the Department of English sponsored the seventh Summer Institute of the Clemson Writing Project. The Bread Loaf Rural Writing Network, Middlebury College's Bread Loaf School of English, and Clemson's Department of English continue their partnership in administering grants to teachers and students in several public schools in the state. Piloted by the Bread Loaf Rural Writing Network in South Carolina, Project REACH (Rural Education Alliance for Collaborative Humanities), which is funded by a Rockefeller Foundation grant channeled through



the South Carolina Humanities Council, operates out of the Department of English. This year the REACH program received a major grant from the Bellsouth Foundation to establish a telecommunications network. This grant is also channeled through the South Carolina Humanities Council.

With leadership provided by a faculty member in the Department of History, the Palmetto Humanities Program brings together faculty from different fields in the college to present programs for residents of the Keowee Key retirement community. The Palmetto Program in the Humanities also was active in Hilton Head this year. Additional outreach activities include faculty from the Department of Performing Arts serving regularly as judges for competitions in such areas as music and theatre in the nation, region and state.

This spring a faculty member from the Department of English served as "Scholar-in-Residence" for the Pickens County School District. He spent three weeks in residence at each of the county's four high schools, conducting classes, directing student performances, holding workshops for teachers and meeting with parents. This highly successful program was funded in part by a grant from the South Carolina Humanities Council.

The College of Liberal Arts serves the entire student body of Clemson University in a variety of ways other than through direct classroom instruction. For example, the Model United Nations Program, which is sponsored by the Department of Political Science, annually competes in and has won awards at national conferences in cities such as Boston, St. Louis and Washington. Political Science also sponsors the State Student Legislature and the government internship program, the former involving an annual competition in Columbia and the latter involving students participating in local, state and national government. The Department of English operates the Writing Laboratory, which is open to all students with writing deficiencies.

The college also contributes to University life by sponsoring a number of student organizations and extracurricular activities. For example, Performing Arts oversees the Clemson Players, the student drama group that stages four plays during the academic year and one during summer school. Some productions have received regional and national recognition. This year, for instance, the play *True West* was presented at Piccolo Spoleto, the first collegiate production ever so honored. Many musical activities are also under the direction of Performing Arts: the University Concert Series, Robert and Lillian Utsey Chamber Music Series, and student organizations including Tiger Band, Symphonic Band, University Chorus, C.U. After Six Singers and Jazz Ensemble. The Symphonic Band was invited to perform this year at the Lincoln Center in New York City. The Gospel Choir is sponsored by the Department of History, while English provides faculty advisers for two students publications: *The Chronicle* and *The Tiger*, the student newspaper which has earned a number of collegiate awards. The English student honorary organization, Sigma Tau Delta, holds an annual writers conference.

The state's public school students make up yet another constituency served by the College of Liberal Arts. The Department of Psychology cooperates with the colleges of Engineering and Sciences in offering a series of summer science camps for gifted junior high and high school youth. The Department of Languages continues to offer instruction in French, German and Spanish to area elementary school students, and the Department of History continues to hold its History Day competition for pre-college students in the Third Congressional District.



## Program Development

Program and faculty development, as well as library acquisitions, will be enriched at Clemson as a result of the College of Liberal Arts having attained its goal of raising \$900,000 in new and increased giving to fulfill the requirements of a \$300,000 Challenge Grant from the National Endowment for the Humanities. Made possible by a gift of \$1.5 million, the proposed R. Roy and Margery W. Pearce Center for Professional Communication will be dedicated to improving the oral and written communication skills of Clemson students, as well as to providing assistance to public schools and the business community. Plans for its implementation, once approval is granted by the Commission on Higher Education, are under way.

The College of Liberal Arts Advisement Center began operations on July 1, 1988, and has as its principal responsibility the academic advisement of approximately 270 undergraduates enrolled as Liberal Arts (undeclared) majors, a category designed for students who have not yet decided on a major area of study and thus are exploring options. The Advisement Center is also involved in the college-wide implementation of a computerized degree-progress report, which monitors students' progress toward graduation. Liberal Arts was one of the first two colleges on campus chosen to implement this report.

Having just completed its second year as an undergraduate major, language and international trade now enrolls 200 students and graduated its first students in May 1989. Language and international trade represents one of the bridges erected by the College of Liberal Arts to span the gap between the liberal arts and the scientific and technological disciplines on campus. This major joins the College of Liberal Arts with the colleges of Agricultural Sciences, Commerce and Industry, and Forest and Recreation Resources in a most successful interdisciplinary effort.

Another continuing and successful interdisciplinary effort joining the colleges of Engineering, Liberal Arts, and Sciences is the Writing Across the Curriculum program, which involves specially identified faculty from the Department of English working with faculty from Engineering and Sciences to improve the writing skills of students enrolled in courses in these two colleges.

The Department of Psychology's Master of Science degree in Applied Psychology with tracks in both human factors and industrial/organizational psychology completed a very successful first year. This graduate program has attracted many more qualified applicants than it can accommodate, and thus is most selective in its admissions.

On June 30, 1989, the College of Liberal Arts completed its twentieth year of service to Clemson University. While the college can indeed look back with pride on its accomplishments, which grow measurably with each successive year, the college prefers to concentrate its energies on looking forward with enthusiasm to the many challenges and opportunities that lie ahead.



## COLLEGE OF NURSING

The College of Nursing offers academic programs leading to a Bachelor of Science degree and a Master of Science degree in nursing and health courses available as a minor or as electives to all non-nursing majors. During 1988-89 these academic programs experienced an increase in enrollment which shows promise of continuing. Professional programs and health care services provided to both professional and lay public through the Continuing Education Program, the Nursing Center, the Wellness Program and Community Nursing Services increased in numbers and diversity. Significant strides were taken toward overall college development goals during this first year of formal development activity. The needs of the public for quality health care and the needs of working nurses in the upstate region for advanced education are being addressed with the establishment of the outreach program in Greenville.

### Administration

Under the leadership of Dr. Opal Hipps, dean, the college has implemented the first year of a five-year plan that outlines specific goals for academic programs, research, service and development. Reorganization of the college has proceeded, with all key administrative positions being filled. Academic programs in nursing and health are implemented by faculty in the Department of Instruction under the direction of Dr. Robbie Hughes. Dr. Sara Barger administers the Department of Professional Development and Services, which includes the Continuing Education Program, the Nursing Center and the University Wellness Program. Dr. Mary Ann Kelly will complete her term as interim head of the Department of Research with the appointment of Dr. Mary de Chesnay, effective August 1989.

As part of support services for college programs under the direction of Dr. Pam Kline, associate dean, two critical positions have been filled. Beth Roberts was appointed director of nursing enrollment November 3, 1988; Mary Reimer assumed the position of director of media resources March 13, 1989.

A formal plan for long-range college development has shown significant results during the first year of activity. A Development Board was formed to guide development activities. Its members are community leaders in South Carolina who have demonstrated interest and support of college activities. William C. Kennerty, Ralph Strong, Thomas A. Roose Sr., Russell L. McCall and Robert C. Springer comprise the Board at present.

A combination of endowed and annual scholarships during 1988-89 totaled \$26,000. Gifts-in-kind totaling more than \$65,000 included specialized equipment and laboratory supplies to be used for clinical instruction. Additional gifts for college advancement and professional development exceeded \$26,000.

The development thrust will be carried forward with the appointment of Pat Padgett as director of development effective July 1, 1989. Priorities for the coming year will include organization and involvement of alumni in support of college goals and securing donors to fund special programs and equipment.



## **Teaching**

In the Department of Instruction courses were offered for nursing majors in both the baccalaureate and master's programs. In addition, health courses were available for non-nursing majors. A total of 64 students were graduated from graduate and undergraduate degree programs during the 1988-89 academic year. Student enrollment during the past year included 273 undergraduate and 66 graduate students.

The extensive recruitment plan initiated last year has begun to show results. Based on paid acceptance, the anticipated enrollment of incoming freshmen for fall 1989 is approximately 100, a more than 50 percent increase in two years. The number of new master's students has more than doubled since fall 1988. Recruitment of minority students, including males, continues to be emphasized along with recruitment of traditional students in an intensified effort to meet the national and regional demand for more professional nurses. A sizable donation from Baptist Medical Center in Easley allowed the Heart of Health Summer Nursing Career Camp to double its size. Twenty non-minority high school students in addition to 20 minority students were enrolled in the week-long experience to acquaint them with college life and nursing career opportunities.

Approval to offer the entire master's program on a part-time basis at an outreach site (Greenville, S.C.) was sought and obtained from the Commission on Higher Education in October 1988. This outreach program will begin with the fall 1989 semester. The program is specifically geared to the working nurse who would find it difficult to travel to Clemson for classes. Classes will be held at the newly renovated Greenville Higher Education Center on the Greenville Technical College campus. Initial reaction in the community has been enthusiastic, with preliminary enrollment projected at 15 students beginning in the fall. This program should help address the shortage of master's-prepared nurses in the state.

Televised instruction for graduate students through Telecampus has demonstrated success. During the past year three courses were offered via Telecampus, enrolling a total of 44 students. Two of these were graduate nursing courses and one was a health course directed at teachers. A third graduate Telecampus course will be taught this fall.

Participation in health courses continued to increase this past year, reflecting the growing public interest in health information and health consumerism. A total of 354 students enrolled in health courses during the 1988-89 academic year, representing a 38 percent increase in enrollment over the previous year. Approval to offer a health minor was obtained; this option will be available to non-nursing majors beginning in the fall 1989 semester.

Overall faculty development in research, publications, scholarly presentations and academic preparation continues to demonstrate progress. Since 1988 the percent of faculty holding doctoral degrees has increased from 41 percent to 44 percent, with an additional 25 percent enrolled in doctoral study.

## **Research**

During its first full year of operation, the Department of Research has expanded functions and personnel in order to focus research efforts and provide needed support for nursing research. In addition to administering externally generated research funding,



the Department has provided funds for pilot research projects of faculty and graduate students and has coordinated expansion and networking of the college's computer capabilities.

External funding for research from federal and foundation sources exceeded \$153,000 for studies in rural health and stress in older family caregivers. Proposals for additional research totaling \$450,000 are pending. Internal funding from University and college sources provided approximately \$5,000, with an additional \$69,000 in proposals pending.

Negotiations are in progress with a health care products company for participation of college faculty in research and development consultation and clinical trial projects with health care products which they manufacture. Consultation has been provided regarding a neurosurgical device and a chronic care device through the Clemson Emerging Technology Development and Marketing Center.

The Department has secured space, equipment and reference materials to support the expansion of nursing research among faculty and graduate students. Plans are to continue active and varied support of research activity as well as to foster growth of research collaboration with industry and health care agencies to improve the quality of health care.

## Service

The Department of Professional Development and Services has the primary responsibility for implementing the service mission of the college through its Continuing Education Program, the Nursing Center, the Wellness Program and the Community Nursing Services.

Under the leadership of its new director, Lynn Lesley, the Continuing Education Program offered 34 courses to 2,073 participants. These programs included a wide range of subjects such as ambulatory surgery, psychiatric nursing, nurse anesthetist conferences, trauma nursing and adolescent pregnancy prevention. A number of changes have been implemented to improve efficiency and cost-effectiveness of the Continuing Education Program.

During 1988-89 the Nursing Center provided nursing service to more clients than ever before. A total of 5,622 client visits were made to the Nursing Center or to screenings conducted by Nursing Center staff at other sites. This number represents a 48 percent increase from the previous year. Screenings were completed under the Early Periodic Screening, Diagnosis and Treatment Program (EPSDT) for Medicaid children, under the Women, Infants and Children Program (WIC), and for a variety of industrial concerns and educational or service programs. Thirty-five cardiopulmonary resuscitation classes were conducted by the center's director, Saranne O'Neal. Revenues increased by 33 percent over last year.

An innovative program for international students was initiated by the Nursing Center in cooperation with the Office of International Programs and Services and Redfern Student Health Center. Seventy-five international students entering Clemson for the first time participated in this program designed to improve their health services. The students had a complete health history taken as part of their Redfern health records. They also received tuberculin skin testing and were offered treatment or further screening as needed.



Despite the vacant director of university wellness program position, the Wellness Program continued to operate with staffing provided by the Nursing Center. The Wellness Challenge served 540 employees and students with screening, health risk appraisal, voluntary aerobic exercise and rescreening after nine weeks. Differences in screening results before and after exercise were measured. Participants received individualized health counseling based on results. It is anticipated that wellness activities will increase with the appointment of Ron Alexander as director effective June 30, 1989.

The Community Nursing Services Program offered nursing services to residents of the Clemson Area Retirement Center under a contract providing an on-site clinic and home nursing visits. Services included case management, health assessment, health screening, health education and skilled nursing care. A total of 240 visits were made to the clinic by residents during this year, and 198 home health visits were made by the program director, Janet Timms, a member of the College of Nursing faculty. A Certificate of Need to offer home health services within a 12-mile radius of Clemson University was granted in March 1989, and an application to receive state licensure as a home health agency is in progress. Licensure will allow expansion of these services beyond the single contract and improve opportunities for student learning in nursing service delivery.

Outstanding faculty accomplishments include the following:

- Jeri Milstead, assistant professor, was named the first South Carolina recipient of the 1989 Search for Excellence Award of the American Nurses' Association based on outstanding achievements in the field of nursing. The award honors a nurse from each state whose practice has significantly changed people's lives. Milstead was honored for her roles as nurse educator, leader in professional organizations and president of the State Board of Nursing for South Carolina.
- Dr. Sara Barger, head of the Department of Professional Development and Services, was elected president of the newly organized Council for Nursing Centers of the National League for Nursing. She will also serve as a member of the Board of Directors for the NLN for 1989-1991.
- Dr. Barger was also elected second vice-president of the South Carolina Nurses' Association. She served as an elected delegate from SCNA to the House of Delegates for the American Nurses' Association, which met in June 1988.
- In March 1989 Dr. Pam Kline, associate dean, was elected chairperson of the Alzheimer's Advisory Committee for the South Carolina Commission on Aging. As a member of that committee and its subcommittee on Education and Training, Kline has contributed to the production of *Alzheimer's 101: The Basics of Caregiving*. Produced jointly by the Commission on Aging and SCETV, this video, manual and trainer's guide will be used for statewide training in the care of Alzheimer's patients.
- Dr. Gloria Tanner, professor, is serving on the Board of Review of the National League for Nursing's Council of Baccalaureate and Higher Degree Programs. This body reviews nursing programs for professional accreditation as part of a voluntary effort to maintain high standards for professional nursing education.



- Dr. Opal Hipps, dean, is serving on the Executive Committee of the NLN Council of Baccalaureate and Higher Degree Programs, which directs the council in its efforts to improve baccalaureate nursing education.
- Notice was received confirming the third year of federal funding for Dr. Betty Baines' study, "An Investigation of Stress in the Older Family Caregiver," from the National Center for Nursing Research. Dr. Baines has made national and international presentations regarding this research.

## COLLEGE OF SCIENCES

During 1988-89 several college committees were formed to examine the quality of instruction in the College of Sciences: Recruiting and Retention, Graduate Student Affairs, Teaching Technologies and Teaching Effectiveness. The committees represent a portion of a collegewide program designed to improve instruction and student learning in the sciences. This is a matter of continuing concern, as this college teaches students in every major in the University.

This year the use of computerized testing and grading in Mathematical Science 105 was begun and has resulted in more uniformity of instruction, testing and grading. The course supervisor designed, administered and graded all tests in two computer testing labs with innovative software that offered each student an individualized test. Tutorial software enhanced student learning by means of immediate feedback from the computer as answers were entered. Course instructors were available in the tutor room adjacent to the labs. The Department of Mathematical Sciences is incorporating procedural changes and expanding this software to improve lab operations for 1989-90.

Dean Bobby G. Wixson organized the Task Force on Lead in Soils for the Society for Geochemistry and Health to set guidelines for acceptable limits. This task force, composed of a group of internationally recognized authorities on this subject, met twice this year.

The College of Sciences was responsible for bringing the Clemson Interactive Video Institute (CIVI) to the University campus. This is a newly formed for-profit corporation that exists in partnership with the Clemson University Research Foundation to which AT&T has transferred the license for its interactive video system. Development of new software, marketing and maintenance of interactive video systems will generate profits to be shared by AT&T, CIVI and the Research Foundation. Using the CIVI software and presentation systems, educators will be able to develop modern innovative teaching tools to improve the quality of education for Clemson undergraduates and maximize the use of today's technology.

Clemson University was host to the Advanced Placement Readings run by the Educational Testing Service (ETS). Clemson is the first remote site to be chosen by ETS for expansion of its programs. Advanced Placement programs developed by the College Board award credit for college work completed during high school. Two chief readers and the director of the reading are College of Sciences faculty members.



Dr. Ernesto Gonzalez, governor of Valle del Cauca, Colombia, visited Dean Wixson and the College of Sciences in March as part of the exchange program established last year between the Universidad del Valle and Clemson University.

Dr. Doris R. Helms was named full-time associate dean for instruction; Dr. Lewis M. Duncan, III, was appointed associate dean for research; and Dr. Peter J. McNulty began his tenure as head of the Department of Physics and Astronomy. Dr. Donald Clayton, world-class scholar of nuclear astrophysics, gamma-ray astronomy and nucleosynthesis, joined the Department of Physics and Astronomy. After a long, nationwide search, Dr. Jack Lilien was selected to be head of the Department of Biological Sciences effective January 1990.

The College of Sciences has extensive research activity, with \$13.6 million in externally funded support for research in force at the end of this year. This is again the largest sum for external funding from non-state sources of all the colleges in the University.

### **Biological Sciences**

This year our undergraduate major in biological sciences completed its third year and continued to attract high quality students. The number of majors increased by 15 percent this year, with 30 in biochemistry, 230 in biological sciences and 15 in zoology. The department's graduate programs enrolled 69 students in research-based master's and doctoral degrees (17 in biochemistry, nine in botany and 43 in zoology). During the 1988-89 academic year the department taught 57 undergraduate and 55 graduate courses and awarded 38 bachelor's degrees, eight master's degrees and six Ph.D. degrees. Graduates of the undergraduate programs continued to excel on a University-wide basis. At Commencement this spring 61 percent of the candidates for departmental baccalaureate degrees earned the status of cum laude or higher (GPR 3.4 or better). Among the recipients of B.S. degrees, Charles Hill received the Norris Medal, the University's most prestigious award, and the Faculty Scholarship Award, and Mary Nan Ellenberg was awarded a highly competitive NSF graduate fellowship.

The department articulated its plan for research emphases following a faculty retreat in September. The plan focused upon the establishment and continued development of four departmental facilities and areas of emphasis: a Biotech/Genome-Mapping Teaching and Research Center, a stress physiology and biochemistry research emphasis, an image analysis facility and a departmental instrumentation facility. During the year resources were secured from both internal and external sources, and all facilities are in operation or soon will be.

Research was supported by 33 externally funded grants and contracts with a total value in excess of \$2 million. Among the sponsors were NSF, NIH, USDA, Sea Grant, NOAA, DOE, S.C. Wildlife, Monsanto, DuPont, Water Resources Commission and the American Heart Association. Several faculty obtained University Research Grants and Provost Awards. Scholarly activities among the 28 full-time faculty included the publication of 43 scholarly papers and articles, 12 chapters in books or monographs and one patent. The faculty, along with their graduate students and research staffs, attended 75 national and international scientific meetings and communicated 65 papers and presentations.



Professional contributions by the faculty included the organization of meetings and symposia. The department and College of Sciences served as hosts to the national meetings of the Mammology Society, and faculty members served as organizers for national and international symposia on "Behavioral Ecology and Science as a Way of Knowing" (American Society of Zoologists), "Biomineralization" (American Chemical Society) and "Southeastern Reservoirs" (American Society of Limnologists and Oceanographers). Included among the faculty are the editors of six scientific journals, the chair of the S.C. Heritage Trust Advisory Board, the chair of the Board of Advisors and president of the Foundation for Highlands Biological Station, president of the Carolina Bird Club, and a member of the University, state and district selection committees for the Rhodes Scholarship Trust. During the year faculty presented invited talks and seminars at 18 institutions throughout North America and Europe.

In January 1990 the department will be led by a new department head, Jack Lilien, currently chair of the Department of Zoology at the University of Wisconsin (Madison). Dr. Lilien brings to the department an international reputation in developmental biology and cell-recognition phenomena. Other faculty changes include the promotion of Dr. L. Dyck to professor, Dr. A. Abbott to associate professor and Dr. H. Skorupska to a joint position with the Department of Agronomy. Dr. A. Wheeler will return from a two-year leave of absence at the University of South Alabama, and Drs. J. Fahey and E. Ruppert will return from sabbatical leaves at European herbaria and the Harbor Branch Oceanographic Institute, respectively. Dr. J. Schindler has obtained a leave from the University to become the director of the Ecosystems Program at NSF, and Drs. D. Heckel and C. Brown will undertake sabbatical leaves in 1989-90.

## **Biology**

During the 1988-89 year approximately 5,500 students were enrolled in courses in the Biology Program. Eleven lecture sections and 70 laboratory sections per week were taught each semester by faculty and graduate students from the Biology Program and departments of Microbiology and Biological Sciences. Summer programs included an Advanced Placement Institute in Biology and courses for pre-college biology teachers.

The Biology Program served as the regional center for the National Association of Biology Teachers Update for the third year. The meeting was attended by 75 high school and college teachers from throughout the United States and Canada. Also, the Biology Program hosted an NABT/Envotech Biotechnology Workshop attended by 25 college and pre-college teachers from the United States and Canada. The Tenth Annual Clemson University Biology Merit Exam was conducted in April with approximately 1,600 attending.

Several grants were awarded to faculty of the Biology Program during the 1988-89 academic year. These included a \$66,000 instrumentation grant from the National Science Foundation, a \$128,000 equipment grant from IBM, three grants totaling \$210,000 to develop materials for the Center of Excellence in Science and Mathematics and a \$63,000 renewal of a grant from the U.S. Department of Education Fund for the Improvement of Post Secondary Education. Twelve grant proposals were submitted by the faculty; six were funded and six are pending approval.



Scholarly activities included 12 published manuscripts, four nationally published laboratory manuals, the development of microcomputer programs and instructional videotapes and the implementation of process-oriented laboratories. A total of 39 papers were presented by faculty at national and regional meetings, including the annual meetings of the National Association of Biology Teachers, National Science Teachers Association, the American Association for the Advancement of Science and the Association for Laboratory Education. One faculty member continues to serve as chief reader for the Advanced Placement Program with the Educational Testing Service and taught five national advancement workshops. Faculty also continue to serve as reviewers for NSF, CSIP and New Jersey Educational Grants. Another faculty member serves as president of the National Association of Academies of Science, the parent organization for all state academies of science.

## Chemistry

The Department of Chemistry continues to move ahead in the areas of undergraduate and graduate teaching, basic and applied chemical research, and service to the community and state.

The general chemistry program is a major part of the total effort of the department since many of the faculty and graduate students are directly involved in the instruction. The total number of registrants in general chemistry courses for the fall and spring semesters was, for the second straight year, 3,200 students. Changes are continuing to take place in the program to increase the percentage of students who successfully complete the courses. The same hourly exams and final exam are given to all students in a specific course, helping to make the grades uniform. Course instructors are providing a large number of optional afternoon and evening tutoring sessions to ensure that all the students' questions are answered. The General Chemistry Help Center under the direction of Dr. James Spain furnishes computer-assisted instruction to the students. Its service has been expanded by the addition of 32 IBM microcomputers, supplied by the Computer Center, and a variety of new instructional software packages, several of which have been produced by Dr. Spain. Through these efforts the numbers of students failing general chemistry are continuing to be reduced.

To improve safety in the general chemistry and organic chemistry laboratories and to increase stockroom accessibility, a new staff position has been approved for 1989-90. The individual occupying this position will be an assistant to the general chemistry stockroom manager and will work in the late afternoon and early evening hours when students are in the laboratory. He or she will have CPR and laboratory safety training.

New graduate teaching assistants are being videotaped by Dr. Melanie Cooper, director of undergraduate laboratories. Chemistry teaching assistants (TAs) are in the graduate program and normally instruct three general chemistry laboratory sections each week during the academic year, each section having about 20 students. During the first week the new TAs present a short practice lecture on a basic chemical experiment. The lecture is videotaped, and the results analyzed by the TA, Dr. Cooper and at least one other faculty member. If the TA does not perform satisfactorily, remedial actions are taken.



The research program of the department has been especially active over the past year with 19 faculty members publishing about 90 scientific journal articles and presenting about 85 papers at conferences and meetings. The faculty received new research grant and contract awards totaling \$1.1 million. Twenty-six active grants and contracts were managed during the year with a combined value of about \$2.5 million. Research purchase expenditures for the year were slightly over \$500,000 with the total departmental expenditures being \$2.4 million.

Some of the young faculty members who have been at Clemson for five years or less are making great strides in establishing excellent research reputations. They are also regarded by their colleagues and students as superior undergraduate and graduate teachers. Noteworthy in this regard are Drs. Joe Kolis, Greg Robinson and Ken Marcus. Each has published a large number of quality publications, has received significant funding, and has been invited to give presentations at international meetings.

Dr. Edith Parsons will join the department this fall as an assistant professor. This brings a third female faculty member to the department and should help attract more women students into the chemistry program. Dr. Muriel Bishop will spend the 1989-90 academic year at the University of Georgia on an NSF research grant.

A major service activity of the department for several years has been participation in the University's summer science camp. This camp brings approximately 250 children in grades 7 to 12 into the department for one to two weeks to discover some exciting chemistry concepts. The chemistry portion of the camp involves primarily laboratory work and is organized by Dr. Muriel Bishop. Six of the faculty were involved with this program, which seems to be growing each year.

In April Dr. DesMarteau resigned as department head after six years in that position. He left for West Germany to carry out fluorine research as part of his Humboldt-Preise from the Alexander von Humboldt Foundation. Upon returning in October he will assume the Tobey-Beaudrot Professorship in Chemistry. Dr. James Fanning was appointed acting head for 1989-90, and the search for a permanent head will begin in September. Dr. Joe Allen replaced Dr. Fanning as assistant department head.

## **Computer Science**

The Department of Computer Science continued to make progress toward the establishment of a mature department with excellent research and instructional programs. This was the eleventh year of the department's existence and the ninth year in which degree programs were offered.

The number of undergraduate majors increased slightly to about 310 in the two B.S. programs. This is down from about 500 three years ago and is consistent with a national trend. This enrollment level should be stable for at least the next year or two. There were 72 B.S. graduates during the year, 32 in computer information systems and 40 in computer science. This is a decrease from 94 B.S. graduates last year, reflecting the declining number of majors.

The graduate program continues to grow stronger. During the past year there were 110 graduate students in the department, with 18 of these being Ph.D. students. There were 17 M.S. graduates during the year, and two Ph.D. degrees in computer science awarded.



Employment prospects continue to be excellent for computer science graduates. The demand for graduates appeared to exceed the supply by a significant margin, and starting salaries were significantly higher. There has been a shift toward more emphasis on academic performance in selecting candidates for positions, however.

Externally funded research remains at about \$1 million in annual expenditures. Good progress is being made in diversifying and expanding the research funding base. The department also continues to be quite successful in attracting equipment donations to support research and instruction, including a donation this year of a \$550,000 hypercube computer system from Intel Corp. Maintenance on our systems continues to be a problem, however, and the annual maintenance costs for departmental computer equipment exceeds the normal budget allocation by about \$20,000, which the department must generate from external sources.

Space continues to be a major problem. The renovation of new space in Jordan Hall has been a great help, but permanent office and laboratory space must be found. The temporary quarters in the Nursing Building have served the department well during its development, but there is not enough space in the building for both the department and the College of Nursing. Plus, the building was not constructed with the needs of Computer Science in mind. The new space in Jordan is completely filled, which limits the department's ability to seek additional equipment donations and external funding.

Faculty recruiting also continues to be difficult, although the department was successful in attracting two new faculty members for 1989-90. Our enviable record of faculty retention remains in danger as our faculty find they can easily find jobs at peer institutions at an increase of \$5,000 to \$10,000 in salary. Some progress was made in improving salaries the past two years as a result of the University's salary adjustment efforts, but substantial additional efforts are still needed.

A third problem is recruiting high quality graduate students. Clemson is again unable to compete with the support levels offered by peer institutions. An increase in assistantship stipends and substantial fellowships is needed.

## Earth Sciences

Earth Sciences completed its third year as a separate department. The department's dominant focus is on undergraduate teaching. Curricula are offered leading to the B.A. and B.S. degrees in geology. Both programs were reviewed during 1988 by consultants for the S.C. Commission on Higher Education. The quality of instruction was cited as being excellent, the faculty as "enthusiastic and dedicated" and the students as "receiving an undergraduate major more like that to be expected at a small private institution compared to most large, research and graduate-oriented land grant universities." The teaching of introductory geology courses to Clemson undergraduates majoring in other disciplines continues to be a prominent mission of the department. In 1988-89, 681 students enrolled in GEOL 101 and 102.

An Earth Sciences Advisory Committee was established to help chart the development of the department. Members of the Advisory Committee met with faculty on May 8, 1989. At this meeting the following goals were identified: 1) initiate a Master of Science degree program emphasizing groundwater geology in collaboration with the



departments of Civil and Environmental Systems Engineering; 2) enhance the geology baccalaureate degree programs so that they become recognized for their excellence throughout the United States; 3) expand recruitment efforts to attract outstanding students; 4) acquire modern equipment to facilitate the research and instructional activities of the Earth Sciences faculty; and 5) design for most efficient utilization of program space after renovation of Brackett Hall.

A proposal requesting approval of a Master of Science degree program in geology at Clemson University was prepared by the Earth Sciences faculty, approved by the University administration and submitted to the S.C. Commission on Higher Education. In response to a pressing demand for qualified hydrogeologists, this interdisciplinary program will emphasize groundwater geology. Two-thirds of the core courses in the proposed curriculum will be in geology, with the remainder coming from engineering.

The Earth Sciences faculty have achieved some success in striving to improve their equipment holdings. In June of 1989 the National Science Foundation advised the Department of Earth Sciences that an award of \$35,000 toward the purchase of an atomic absorption spectrometer was forthcoming. Negotiation is under way to transfer an automated electron microprobe from the Laboratory for Extraterrestrial Physics at NASA's Goddard Space Flight Center to Clemson's Department of Earth Sciences.

Dr. Keith Miller joined the faculty in January, 1989 as visiting assistant professor of geology. Dr. Miller's research interests focus on the complex relationships between sedimentary processes and living communities in shallow marine environments, and applying dynamic models of environmental and faunal change to stratigraphic correlation.

Other noteworthy individual accomplishments of the Department of Earth Sciences faculty during 1988-89 are as follows. Dr. Vil Griffin, professor, undertook a gamma radiation survey of Piedmont rocks; Dr. George Haselton, professor, gave a talk at the International Union for Quaternary Geology in Cromer, England; Dr. Dave Snipes, professor, was designated a sole source contractor to study the location, offset and age of a newly discovered fault at the Savannah River Laboratory; Mr. John Wagner, assistant professor, was principal investigator of a \$38,867 grant, "Preparing Students for Science in the Nineties," awarded by the S.C. Commission on Higher Education under the Dwight D. Eisenhower Act; Dr. Richard Warner, associate professor and acting head, published a chapter in *Geological Society of America Special Paper 231*, "Ultramafic Rocks of the Appalachian Piedmont."

### **Mathematical Sciences**

The department continued its strong commitment to teaching by once again offering one-eighth of the total credit hours at the University. In fact, the teaching load once again increased more than five percent over the previous year. The department awarded 34 bachelor's degrees, 36 master's degrees and six Ph.D. degrees. In addition, faculty served on many University committees including, the Faculty Senate and the Computer Advisory Committee.

Members of the faculty continued their national prominence by serving on committees for many professional societies from the Society for Industrial and Applied Mathematics to the Mathematical Association of America. Faculty were prolific schol-



ars issuing 32 technical reports, nearly all of which were also submitted for journal publication, as well as publishing two prestigious research monographs. The department enjoyed its third year of the large Office of Naval Research block grant as well as other contracts with ONR and the National Institute for Science and Technology, while submitting several more proposals for funded research. One faculty member was involved in a state-supported school bus scheduling project; another served as chairman of the international meeting of the Classification Society; another worked in the National Science Foundation as director of the new calculus program and served on the executive committee of the MAA. The department also had its first Humboldt fellow this year and continued its successful and annual discrete mathematics fall conference.

The faculty continues to participate in projects related to the improvement of mathematics teaching. Specifically, the Center of Excellence in Mathematics and Sciences Education was renewed. Courses were taught under an EESA grant and under an AP teacher training program, as well as in the "critical needs" off-campus teacher program. Some faculty began work in the FIPSE program of the Department of Education to develop and teach courses in calculus, differential equations, linear algebra and statistics using programmable graphics calculators. In addition, the department instituted a new mathematics testing laboratory for the precalculus course and hosted 225 calculus Advanced Placement graders on campus in early summer.

In August 1988 five new faculty (Professors Chang, Ervin, Kulasekera, Jeffries and Sullivan) and five visiting faculty joined the department. Additionally, two new instructors and more than 25 new graduate assistants helped with teaching duties. Seven new faculty members were hired for the coming year at all levels (Professors Key, Kiessler, Nelson, Robinson, Saltzman, Sun and Wiecek). The department continues to attract graduate students from a wide geographic distribution. The students who begin in August 1989 did their previous work at institutions in 14 different states. Students who graduated during this year with the Ph.D. degrees began their careers at outstanding colleges and universities from research schools such as the University of Tennessee and the Naval Postgraduate School to smaller colleges such as Towson State and Kennesaw College.

The department was allocated some of the salary adjustment funds to help bring faculty salaries up to standards. Goals related to improved equipment and physical facilities began to be met as well.

### **Medical Technology**

The Medical Technology Program completed another productive year of teaching, advising, administrative activity and club sponsorship. The program currently enrolls about 25 students. Seven entering freshmen and four transfer or change-of-major students joined the medical technology curriculum. This was offset by nine students transferring out of the program. In addition five students completed the baccalaureate degree requirements for graduation. Our senior clinical-year students continue to excel on the national certification exam. All have been successful in finding employment in the profession. With nationwide shortages in the profession, the number and range of professional opportunities is presently very large.



Senior-year clinical courses continue to be offered by hospital program affiliates. Our formal affiliation programs are with the schools of medical technology at Anderson Memorial Hospital in Anderson, S.C., and at McLeod Regional Medical Center in Florence, S.C. Informal affiliations exist with the medical technology programs at the Medical University of South Carolina in Charleston, S.C., and the Baptist Medical Center in Columbia, S.C. This year five rising seniors were accepted by and have chosen to attend the nearby Anderson Hospital program. The Anderson program continues to help teach the introductory medical technology course taken by new majors.

With the advent of government restrictions limiting health-care reimbursements to hospitals and other providers, many hospital-based programs in health education need to develop additional sources of funding for fiscal stability. Through the Medical Technology Committee the University has instituted a plan whereby Clemson University provides a significant amount of support to the Anderson Hospital School of Medical Technology for each Clemson clinical student in attendance in return for a guarantee of eight places in the class. This agreement is being renewed for a second two-year period.

The current program coordinator continued to promote medical technology by group and individual presentations to students and teachers from around the state and by participation in the spring annual meeting of the S.C. Society for Medical Technology.

The student Medical Technology Club completed another successful year of activities including a trip to the Greenwood Genetics Center, presentations by speakers and service projects.

## **Microbiology**

There were 82 students majoring in the microbiology B.S. degree program, 25 in the M.S. and 16 in the Ph.D. Twenty baccalaureate, nine master's and two doctorate degrees were awarded. B.S. graduates continued their education in medical or dental schools, embarked upon M.S. or Ph.D. programs, or accepted positions in the private sector. Of the nine M.S. graduates, five began doctoral programs, one entered medical school and three accepted research technical positions. One doctoral graduate was employed in research and development by Texaco Inc., and the other took a post-doctoral position at the National Institutes of Health.

The department played an important part in the educational aspects of the biotechnology efforts. An advanced graduate course in genetic engineering techniques was offered to 20 students during the fall semester, and an intensive 10-day short course was provided for 12 faculty members in the College of Agricultural Sciences.

Several faculty members were part of the team developing a new biotechnology thrust, Food Safety through Microbiology.

Research grants and contracts totaling \$854,700 were in force throughout the year. Sources included USDA, NIH, NIDR, ERDC, Food Science Corp. and Monsanto Co. Several faculty members played key roles in an interdisciplinary effort that resulted in a \$300,000 award to the University from the Self Foundation to purchase state-of-the-art biotechnology equipment. A Peace Fellowship was received from the Egyptian Government to support a post-doctoral student from the Central Agricultural Research Center, Giza. The purpose was to provide training in modern biotechnological techniques.



The Monsanto-sponsored field test to evaluate survival in soil of a genetically engineered bacterium (an interdisciplinary project also involving the departments of Agronomy and Soils, and Plant Pathology and Physiology) was successfully concluded. A second field test using a genetically engineered bacterium was also completed, and a third project was initiated. Clemson University has become one of the few institutions in the nation approved by the EPA to conduct such studies.

Other projects undertaken in the department included: the microbial degradation of herbicides in anaerobic aquatic sediments; biological nitrogen fixation by a halotolerant bacterium that associates with sea grass plants; diseases of catfish and their immunological response; chemical stimulation of the immune response; the genetics and control of cellulase enzyme production; effective conversion of residual cellulose in extracted alfalfa to sugars; genetic engineering of rhizobia for improved biological nitrogen fixation; genetic engineering of lactic acid bacteria for improved food processing and production; hormonal control of DNA expression in mouse melanoma cells; regulation of procaryotic and eucaryotic DNA expression by low molecular weight metabolites; interactions of chemical carcinogens with repair of UV-damaged DNA; interaction between methanogenic and sulfidogenic bacteria; characteristics of the cellulase complex produced by a salt marsh bacterium; and studies on destruction of the immune defense system active against the bacterium that causes dental caries.

Faculty published 20 research papers and one invited book chapter. Twenty-eight presentations were made at professional scientific meetings, including the Third International Chemical Congress and the First International Meeting on Risk Assessment of Released Genetically Engineered Microbes. Numerous seminars were given, notably at the University of Brussels (Belgium), the University of Birmingham (U.K.) and Harvard University. The department organized the Third Annual International Bioprocessing Conference; Animal Cell Culture, held in Atlanta in December. Dr. T. A. Hughes was recognized for his excellence in teaching by being named a Calhoun College Honors Professor. Dr. F. J. Stutzenberger was recognized for his scientific expertise by being appointed North American Editor of Letters in Applied Microbiology and to the editorial board of the *Journal of Industrial Microbiology*.

### **Physics and Astronomy**

The department began the academic year with a new department head, Dr. Peter McNulty, and two new faculty members, Dr. Robert Panoff and Dr. Guebre Tessema. Dr. McNulty comes to Clemson from Clarkson University, where he was a professor of physics. His research interest is in the effects of radiation on microelectronics flown in space. Dr. Panoff comes from Kansas State University with a research interest in quantum Monte Carlo methods. Dr. Tessema comes from Memphis State University; his research is on charge density waves. Also, Dr. Lewis Duncan, who will serve the College of Sciences as associate dean for research, started with the department following a year's leave at Stanford University as a Carnegie Science Fellow at the Center of International Security and Arms Control. Before that, Dr. Duncan was a section head at Los Alamos National Laboratory. Dr. Duncan's research interest is in plasma studies of the Ionosphere.



Three of our faculty, Professors Edward Gettys, Fred Keller and Malcolm Skove, completed an introductory textbook, *Physics, Classical and Modern*. It has been published by McGraw-Hill, who refers to it in their extensive advertising as "the newest force in physics." It is currently in use at Clemson and at 25 to 30 other universities. More than 16,000 copies have been sold.

The department received a Cutting Edge award for \$96,000 for a proposal submitted by Professors L.L. Larcom, M.F. Larsen, J.R. Manson, P.J. McNulty, D.P. Miller and J.R. Ray. This initiated a significant increase in our federal funding from a level of \$225,344 per year last year to \$757,126 per year this year. External funding in this year's budget includes: \$70,650 from NASA and \$35,000 from Los Alamos for Dr. Lewis Duncan; \$63,023 from the Air Force and \$40,000 from NASA for Dr. Miguel Larsen; \$90,300 from DNA and the Air Force for Dr. Peter McNulty; \$241,000 for three years from NSF to Dr. G.X. Tessema; \$104,750 from NSF for Dr. Carl Ulbrich; and a joint award of \$52,253 from NASA to Dr. Carl Ulbrich and Dr. Lee Miller, a visiting professor. The head of the electronics shop, Jim Eubanks, received \$20,000 from Duke Power Co. This funding level should be relatively secure, since much of it is in the form of multi-year grants and contracts totaling \$1,946,080.

The department is being joined next year by Professor Donald Clayton, a theoretical astrophysicist. Professor Clayton comes from Rice University where he held the Andrew Hays Buchanan endowed chair in Astrophysics. He is a Fellow of both the American Physical Society and the Meteoritical Society. He has held an Alfred P. Sloan Fellowship, an Alexander Von Humboldt award and a Fulbright Fellowship. Professor Clayton brings international attention to Clemson's astronomy group. He is co-investigator of the Gamma Ray Observatory Satellite to be launched by NASA in June 1990. He has written five books, including one novel.

Dr. Miguel Larsen was promoted from associate professor to full professor. Professor Larsen also received the Sigma Xi Outstanding Researcher Award for 1988-89. Dr. Malcolm Skove, Alumni Professor, retired following a distinguished career of 28 years in the department.

Dr. Amulya Laskar was co-director of a NATO Advanced Study Institute on "Diffusion in Materials." He is currently assembling and editing the text of the lectures. Professor Edward Gettys has been appointed examinations editor for the American Association of Physics Teachers. He continues as the Advanced Placement chief reader in physics. Professor Carl Ulbrich was named Calhoun College Outstanding Honors Professor.

The department held its annual Physics Day, organized again by Professor Tom Collins for 37 high schools and more than 1,200 students. Students attended lectures and demonstrations by Professors Ray Turner, Dick Manson, John Gilreath, Bob Panoff, Henry Vogel and Don Miller. High school teachers and counselors met with Professors Gilreath and McNulty over coffee. We expect this program to significantly impact recruiting in both engineering and sciences.

Provost Awards were received this year by Professors Ray Turner and G.X. Tessema. Professors Phil Burt and Dick Manson received travel awards for research. Professor Bob Panoff received a University Research Grant award. Professor Don Miller received support for a one-semester sabbatical at the University of Grenoble.



## DIVISION OF AGRICULTURE AND NATURAL RESOURCES

The Division of Agriculture and Natural Resources is responsible for instructional, research and public service programs in the College of Agricultural Sciences and the College of Forest and Recreation Resources.

In addition to its programs for resident instruction, the College of Agricultural Sciences administers statewide public service programs that serve businesses, industry and virtually every citizen of the state. These public service functions include administration and coordination of the S.C. Agricultural Experiment Station, the Clemson Cooperative Extension Service, the Division of Regulatory and Public Service Programs and the Livestock-Poultry Health Department.

The scope of the College of Forest and Recreation Resources' programs also spans the entire state and touches the lives of all South Carolinians through teaching, research and Extension activities in forest management, wood utilization, recreation resources and services and tourism management.

Since their inception, the agriculture divisions and their leaders have emphasized agricultural production and improved family life, thus laying a strong foundation for the future. As the University begins its second century, objectives of the agricultural units are to increase productivity, increase employment opportunities, and conserve and protect natural resources.

Researchers completed a test of the first microorganism containing genes from two separate sources to be placed into a field environment. The genetically engineered system, developed by Monsanto Co., worked perfectly, with the organism staying within a narrow zone on wheat roots.

A follow-up test of a similar organism, with the Monsanto tracking system inserted, was conducted on wheat planted at the Edisto Research and Education Center last fall. The organism, which has shown control activity against wheat take-all disease, was tracked throughout the growing season. The test is now being evaluated.

Another significant highlight this year was the addition of rain forest property on the island of Dominica, West Indies. The property was donated to Clemson by owner John D. Archbold, a native of Virginia. A consortium of other universities and research institutions was formed this year to conduct research projects on the island. To be operated through the College of Forest and Recreation Resources, Clemson researchers will carry out studies in ecology, resource management, economic development, parks and tourism management and environmental engineering.

As the Cooperative Extension Service's 75th anniversary was celebrated across the nation this year, Clemson's Extension program was stronger than ever. A big success was Clemson's Palmetto Leadership/Community Development pilot program, which successfully completed its first phase this year. Coordinated by the Clemson Extension Service, this program aims to revitalize the state's rural communities through local leadership development. About 35 veteran and emerging leaders in each of the program's four pilot counties were trained and have identified specific problems in their counties on which to begin work. The pilot counties are Abbeville, Dillon, Kershaw and Saluda. The three-year program is funded by a \$1.1 million grant from the W.K. Kellogg Foundation of Battle Creek, Mich., and matching funds from Clemson University and the state of South Carolina.



## COLLEGE OF AGRICULTURAL SCIENCES

### Agricultural Instruction

The College of Agricultural Sciences satisfies the mandate of the will of Thomas Green Clemson, "to afford thorough instruction in agriculture and the natural sciences connected therewith..." through the 17 undergraduate curricula and master's and doctoral programs administered by the college.

Agriculture is an increasingly complex, dynamic, professional field. Worldwide, agriculture is the major force in alleviating undernourishment and malnutrition. In the United States agriculture is a major positive factor in the balance of trade and accounts for up to 20 percent of the nation's employment. Remarkably, less than 3 percent of the population is directly involved in the production of crops and livestock. In South Carolina the agricultural industry generates up to \$3 billion annually in the state's economy, including crop and livestock production (about \$1 billion) and all aspects of value-added industries such as food packaging and processing.

South Carolina's agriculture is changing. Food manufacturing, processing and packaging are rapidly expanding industries along with the production of ornamental plants and turfgrass. Traditional crops and livestock remain important to the state's economy. Agricultural graduates are prepared to serve this major industry in the state, the nation or worldwide.

Recognizing problems and applying basic principles to finding solutions is a fundamental element of undergraduate education in agriculture. Problem recognition/solving skills are stressed along with the mastery of a body of current information. Developing skills in five broad areas forms the foundation of undergraduate curricula: communications, business, people management, basic sciences and a field of technical agriculture.

A curriculum committee composed of faculty, extension and private sector personnel is studying the entire college curriculum to suggest changes that will help meet the demands of a changing industry and new styles of teaching. One suggested direction from the committee is the need for senior-level interdisciplinary courses that allow the student to apply the skill from all five of the above broad areas to solving actual agricultural problems.

The basic structure and philosophy of the land-grant institution — the emphasis on practical service and the association of teaching, research and extension in a common administrative unit — help ensure students are exposed to the most current facts and theories, as well as to problems, issues and controversies. The classroom teacher is also a research scientist or Extension specialist. In addition, students benefit from equipment and facilities associated with research responsibilities.

Quality teaching is of major concern to the college. This year, programs providing ideas for improved teaching methods were offered to the faculty. In addition to University responsibilities, teaching faculty continue to be active in a variety of professional programs, organizations and activities stressing teaching. Professor Tom Garner received the National Association of College Teachers of Agriculture's Teaching Award in 1988-89. The college is moving ahead in new and exciting teaching methods involving Telecampus courses, computer-assisted instruction and other technical improvements.



The trend of increasing enrollment for the college is continuing. To capitalize on this enrollment trend and the efforts of the College Recruitment Committee, a new position, coordinator of student relations and recruitment, was created. This office's primary goal will be to recruit quality students for the college. In the future the office hopes to work on career placement for agricultural science graduates and other areas of student and college relations. This position will provide great benefit to our state.

### **International Agriculture**

The University assumed many responsibilities for international programs in 1987-88. The college continues to serve international students at all degree levels as well as faculty exchanges. No new programs have been initiated, although several faculty have formalized arrangements for foreign assignments in the coming year, and a variety of foreign visitors have been scheduled.

### **Continuing Education**

In addition to the numerous programs provided through Extension, many short courses, workshops and seminars are presented through continuing education efforts. These programs are designed to assist all phases of agriculture. Several programs have become essentially permanent, including the nematode short course and the bankers short course. In 1987-88 policy was modified to allow CEUs to be awarded for selected, Extension in-service training programs.

In all program areas the college is still adapting to recent changes in administrative structure and personnel. The commitment is to maintain the record and reputation of superior service to agriculture.

## **SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION**

The S.C. Agricultural Experiment Station at Clemson conducts the state's only state-funded agricultural research program. Scientists in 13 departments of the College of Agricultural Sciences provide expertise for this program, while home economics research is conducted at Winthrop College.

Facilities at Clemson and at four research and education centers located across the state provide indoor and outdoor laboratories for scientists in agricultural economics; agricultural education; agricultural engineering; aquaculture, fisheries and wildlife; agronomy; animal science; dairy science; entomology; experimental statistics; food science; horticulture; plant pathology and poultry science.

Branch research and education centers are Edisto at Blackville, Sandhill at Pontiac, Pee Dee near Florence and Coastal near Charleston. The Simpson Experiment Station near Pendleton also serves as an outdoor laboratory for researchers and faculty on campus.

Researchers at these regional centers conduct studies and carry out experiments relating to growers, livestock and crops in their respective geographic areas under constraints and conditions of different soils and climates.



During this fiscal year the Experiment Station strengthened its current research programs and addressed future needs by responding to new concerns in agricultural industries. New areas include a three-pronged approach in biotechnology research that will improve animals, plants and food safety. Research efforts in packaging science, aquaculture and ornamental horticulture were also expanded. Research programs will continue to be redirected to meet the demands and needs of the public so they can make wise decisions based on the knowledge provided.

In all 50 states experiment stations conduct both cooperative and complementary research. They avoid duplication of efforts and build on the foundation of information which has been primarily responsible for advances made in agriculture during the past 100 years.

To meet future challenges, the South Carolina Agricultural Experiment Station will continue to produce new research findings to add to those of its counterparts across the country in meeting a common goal — creating better standards of living for people through the wisest and best use of natural resources.

The following summary is a capsule review of the extensive research program at the Experiment Station. Many important studies are not included, and those that follow are intended only to illustrate the scope of the station's total program.

### **Agricultural Economics and Rural Sociology**

The primary missions of Agricultural Economics and Rural Sociology are to conduct research that improves the efficiency of agricultural production in South Carolina; to help make South Carolina agriculture more competitive relative to other geographic areas of the U.S. and other parts of the world; and to predict the effects of changes in national and international economic conditions and changes in U.S. government programs on agriculture and rural areas in South Carolina and nearby areas. One should keep in mind that more than 80 percent of South Carolina's land area is devoted to farming or forestry.

Research in the department shows that since 1983 cash farm receipts in South Carolina from poultry production have increased 37 percent from \$155 million annually to \$213 million annually. Research on Southern farm and rural labor markets has shown that farm wage rates and farm labor employment are dominated by manufacturing activities in nearby geographic areas.

Flue-cured tobacco is still the number-one cash crop in the state. Recent research has shown that flue-cured tobacco quota sales values drop an average of 16 cents per pound for each one-year reduction in the expected life of the tobacco price support program. Second, it has been determined that a 25 percent increase in flue-cured tobacco quotas will increase the gross state product in South Carolina by up to \$85 million per year.

S.C. commercial catfish and crawfish production is becoming more economically viable. There are now more than 150 commercial catfish producers in South Carolina and more than 40 commercial crawfish producers. Sales of ornamental and turf products are increasing rapidly in South Carolina. Total industry sales in this state surpassed \$66 million in the past year.



Poultry and swine enterprises usually require a great deal of investment capital. Recent research has shown that because of these capital requirements, poultry and swine may be poor substitutes for corn and soybeans, particularly in the Piedmont area of the state. Likewise, because of the large amounts of capital investment required, poultry and swine may be poor substitutes for tobacco and corn in the Pee Dee region.

Recent marketing research indicates that uncertain yields and market prices for cotton and soybeans over the last few years can be alleviated to some extent either by using commodity futures markets or by other means of forward contracting.

There are four important factors in shaping beef cattle profits in South Carolina: (1) using forages whenever possible as feed substitutes for grains, (2) using performance-tested bulls and proven brood cows, (3) replacing brood cows before they significantly drop off in milk production and in calving rates, and (4) optimal timing in selling calves and feeder animals.

Computer simulation models of farm business firms have shown that small grain farms that have high levels of debt (more than 70 percent of debt relative to total assets) are much more vulnerable to financial stress than are medium-size farms. Large family farms also have more difficulty in financing their assets than medium-size family farms.

Agriculture in the United States and South Carolina continues to be more efficient. U.S. consumers now spend less than 13 percent of their disposable income on food. This compares to more than 25 percent in Japan, around 23 percent in West Germany, 40 percent or more in Mexico, 45 percent or more in the Soviet Union, and more than 60 percent in China.

### **Agricultural Education**

Research in Agricultural Education centers on learning, curricula developmental delivery methodologies, assessment of program relevance and program effectiveness, and projection of future educational needs of youth and adults involved in or affected by the broad agricultural industry.

In a 10-year follow-up study of 155 Clemson University enrollees in 1977, findings indicate that many general education competencies (e.g., oral communication and problem-solving techniques) are valued much more highly than specific agricultural competencies (e.g., feed nutrient requirements for livestock and poultry and controlling livestock/poultry diseases) for initial employment and career advancement.

### **Agricultural Engineering**

The mission of the Agricultural Engineering Department is to provide the engineering input for the management of biological and agricultural systems and human and natural resources for effective and efficient production, processing, storage, distribution and utilization for the food and non-food needs of society. Eight of 40 research projects are highlighted here.

Algorithms were developed to use X-ray techniques to detect split pits in peaches. Split pits can cause extensive spoilage in fresh peaches in a short time after harvesting.

Research work was conducted in a peach orchard in Edgefield County to determine the movement of nematicides when applied through a trickle irrigation system. The nematicides did not move more than one meter below the soil surface.



The Integrated Pest Management (IPM) program sponsored research on monitoring grain storage facilities to detect when conditions are favorable for insect infestations. If undetected, these conditions can lead to millions of dollars in losses to the agricultural industry of the state.

An expert system was developed for site assessment and design of municipal sludge land application systems. This will assist municipal personnel and consulting engineers to properly design land application systems so that the soil and water resources will not become contaminated.

The use of special semi-permeable membranes for processing waste streams from several industries could result in substantial cost savings. The industries tested included Sara Lee, Inc., for their boiler at the bagel production facility, seafood industry on their brine water, and a dairy plant on milk and ice cream mixtures. The membranes made it possible to salvage some of the valuable organic portions of the waste, and the water permeate could be used in recycling.

Research is being conducted on water quality problems related to intensive aquaculture systems. Maintaining proper oxygen levels is vital to the efficient production of fish. Various wastewater treatment methods have been tested to make the water of such a quality that it can be recycled.

A planter has been designed and tested to interseed soybeans into wheat prior to harvesting the wheat. Field tests at the Edisto facility have shown that interseeded soybeans produced significantly higher yields than conventionally grown soybeans. This system also requires less energy input in that only one deep tillage operation per year is needed.

Tobacco curing models have been developed for maximizing energy inputs in bulk box tobacco barns. Air flow characteristics of the two metering devices (pressure-box and slotted-plate orifice) were used to collect information on five barns.

## **Agronomy and Soils**

Genomic libraries of tall fescue and two fungal isolates of the endophyte that infects the forage have been developed under the Cutting Edge grant received from the University last year. These libraries will be used to begin molecular mapping. The project is one of several new biotechnology activities initiated by Clemson scientists.

New barley and wheat cultivars will be released next year from the small grain breeding program. The barley cultivar, which is awnless and early maturing, will replace Redhill. The wheat cultivar also will be early maturing and therefore well-suited for double cropping.

Williams, a wheat cultivar released in 1984, has demonstrated excellent resistance to Hessian fly, a pest of increasing economic significance. Growers need to take advantage of this excellent source of germplasm from Clemson's breeding program.

A promising soybean breeding line will be made available for seed increase to Foundation Seed at the end of the current growing season. The line has resistance to cyst nematode Race 3. It has performed well in Clemson's variety evaluations and in variety tests within the Southern region. Seed should be available for production of registered seed for the 1991 growing season.



A herbicide resistant biotype of *Palmer amaranth*, the most prevalent broadleaf weed in South Carolina, has been discovered. The resistance to dinitroaniline was confirmed recently. This can be a serious blow to row crop production. Clemson weed scientists are exploring alternatives.

Scientists from the Agronomy and Soils and Agricultural Engineering departments are involved in a project to develop and evaluate low-input reduced-tillage systems for interseeding soybeans and other crops into standing wheat. Related investigations include studies of yield, soil compaction, and energy requirements of various tillage and interseeding treatments; evaluation of soybean and wheat growth in the interseeded environment; and development of weed management systems for interseeding. Other aspects of this project include studies of soil loss and runoff for interseeded soybeans, development of improved equipment for interseeded systems and evaluations of interseeding systems as cost-effective practices for double-cropping soybeans or cotton with wheat.

### Animal Science

The research and teaching missions of the Animal Science Department concentrate on cattle, pigs, horses and sheep with four primary discipline areas: breeding and genetics, reproductive physiology, animal nutrition, meat science and muscle biology.

Research was conducted evaluating the effect of an endophytic fungus in fescue pastures on beef steers, heifers and horses. The endophyte in fescue reduced performance of beef steers and heifers and affected estrus and lowered conception rates in heifers. The fungus was much more toxic to horses, resulting in agalactia, prolonged gestation lengths, foaling difficulties, increased foal mortality and lowered plasma prolactin, estrogen and progesterone levels. There was quick recovery from the toxic effects of the fungus when horses were moved to endophyte-free pastures. Endophyte-free pastures were interseeded with rye and crimson clover and used to evaluate continuous versus short duration grazing (SDG) with beef steers. Results from the first year — a drought year — of grazing suggested that there was no advantage to SDG. A procedure was developed for bio-assaying the toxins in fescue using the milkweed bug.

An evaluation of luprostiol, a compound that can induce birth in swine, was conducted on a producer's farm. Results showed it was effective and efficient for synchronizing birth in swine. This will make it possible for producers to save more baby pigs at birth and to spend fewer hours in the farrowing house.

There are a number of enzymes required for normal ovulation to occur. A pilot study was completed in which the action of one enzyme was studied. Treatment of female pigs with an inhibitor of this enzyme resulted in a significant increase in the ovulation rate. If subsequent studies support the initial findings, the inhibitor could be used to help decrease the number of litters born with low numbers.

Twenty multiparous lactating, cyclic beef cows that calved in moderate body condition were used to determine effects of restricted nutrition on the development and function of corpus luteum—the point on the ovary where the egg is produced and released. The study showed that restricted nutrition leading to an anestrus state does not affect corpus luteum development, but does affect its functional capability to produce progesterone.



The beef and pork on the market today are higher in protein and lower in fat than traditional meat products. Clemson research has emphasized the use of genetic selection and the use of large amounts of low-energy feed (forage) in the animal diet. Clemson research has emphasized the fatty acid component in beef and pork products and has shown that more than 50 percent of the fat is mono or poly saturated and that a large amount of the saturated fat is stearic acid, which is readily converted to a mono-unsaturated fatty acid (oleic acid).

### **Aquaculture, Fisheries and Wildlife**

The most significant contribution of the Aquaculture, Fisheries and Wildlife Department this year was its role in recruiting the nationally recognized Institute of Wildlife and Environmental Toxicology from Western Washington State University. The faculty, through several bold decisions, made it possible for the University to offer the institute a new home.

Several crawfish research projects were completed this year, including work on crawfish diversification, nutrient budgets (water quality) and the computerization of a survey of toxic effects of pesticides on crawfish.

A new laboratory is being completed to conduct research funded by two grants: "Characterization, Manipulation and Control of Factors in Food-borne Pathogenesis" and "The Effects of Selected Pesticides on the Immune Response of Channel Catfish." Three refereed journal articles were published on improving the efficiency of catfish production systems by manipulating the stocking size of fingerlings and the use of a device to allow small fish to compete with larger fish for food. A low-cost heat exchange device for aquaculture systems is described in another new publication.

Work is completed and results submitted for publication on a removable bifiltration system for hatchery troughs and toxicity of ammonia to red drum fingerlings.

Research on in-stream flow models was recently applauded as the most significant presented at a U.S. Fish and Wildlife Service workshop. This work is used to determine impacts of altered stream flow.

The Delta Waterfowl and Wetlands Research Station's Atlantic Flyway Substation (DAFS), a cooperative effort between Delta, the S.C. Wildlife and Marine Resources Department and Clemson aquaculture department, was operational as of January 1989. David H. Gordon, the substation's director, is coordinating a team of scientists working on proposals for new research initiatives that will center on wintering waterfowl ecology and the impacts of management regimes on coastal wetlands. Among the scientists working with Gordon is Bob Trost, leader of the new U.S. Fish and Wildlife Service Cooperative Research Unit, housed in the aquaculture department.

### **Dairy Science**

Research thrusts in this area include nutrition of dairy animals, physiology with the principal interest in reproduction, animal health and dairy manufacturing to include problems of milk product processing and new dairy food products.

Data from a two-year efficacy trial and two years of field study with the use of sustained-release bovine somatotropin (BST) are being analyzed. Effects on lactation,



reproduction and health of dairy cows to date have been favorable. Milk production has been increased approximately 20 percent, with an improved feed efficiency of 5-10 percent. No health problems or reproductive disorders have been associated with use of BST. A trial using BST in high-producing Jerseys is being set up using daily injection of BST with needle and needleless injections.

Research regarding mycotoxins and the immune response was conducted, with the effects of AFB1 on turkey peripheral blood lymphocytes being reported. Also effects of bovine T-cells and macrophages in vitro were completed and reported nationally. DNA binding studies of aflatoxin B1 in calf and shark livers in vitro were conducted collaboratively with Mote Marine Laboratory in Sarasota, Fla.

Two patents were filed for a turkey seminal plasma protease and a discovery organism.

Research with low concentrated ultrafiltrated milk and the manufacture of blue cheese was summarized and submitted for publication in the *Cultured Dairy Products Journal*. A paper was presented on the results of research on carbonated orange-flavored sherbet. Evaluation of the product has been acceptable, though a similar product frozen with air was preferred by more of the tasters.

Research was initiated in the area of rapid detection of microorganisms for the production of milk shelf life. Molecular biology techniques are being used for this detection.

Effects of commercial serum replacements on cultured murine embryos have been submitted and accepted for publication. Replacing BSA with commercial serum substitutes and its effect on cultured embryos from farm species continues, and results are being prepared for publication.

## Entomology

Entomological research is focused on pushing back the frontiers of knowledge; to render service in the form of research information to the citizens of the state, nation and world; and to develop collectively and individually as professional entomologists.

The principal research thrust is in the areas of low-energy, comprehensive integrated pest management (IPM) technology. The main objective is to maintain pest populations below economically damaging levels while reducing the use of expensive and ecologically disruptive pesticides. Basic and applied research programs are listed below.

The tobacco budworm, a major pest of cotton, was found to have genetic resistance in the biochemical targets of insecticides. Acetylcholinesterase from a South Carolina collection was resistant to methyl parathion, an insecticide. This trait was observed to segregate as a single gene and to be linked to a genetic marker locus. A field assay for this gene allele has been developed. Nerve insensitivity to permethrin insecticide was demonstrated in an experimental strain, indicating a change in the sodium ion channel protein, the target of pyrethroid insecticides and DDT. A putative DNA marker for this resistance was identified by restriction fragment analysis.

Research on the population dynamics of the corn earworm *Heliothis zea* has led to the initiation of attempts for areawide management of this pest. The goal of the project was to reduce the population early in the season in corn in an effort to reduce the



numbers present later in the season that cause considerable damage in cotton and soybeans. During the 1988 growing season the biological agent *Bacillus thuringiensis* var. Kurstaki (trade name Dipel ES) was applied three times on approximately 200 acres of corn in an attempt to suppress early season numbers of this pest. These applications resulted in a 75 percent reduction in the first generation corn population. Although these results were promising, the mortality level was not high enough to produce reductions that persisted past the second corn generation. Studies to increase mortality are planned for the coming year.

The continued production of minor (acreage) crops is dependent on the use of crop protection chemicals. Without these chemical tools, many familiar and important South Carolina crops could no longer be grown. Registration of minor and specialty uses of pesticides is assisted through the IR-4 research effort within the department.

Lyme Disease, a tick-borne bacterial disease, has recently been diagnosed in several state locations. This disease can lead to a devastating condition resulting in a lifetime physical debilitation. The Lyme Disease organism is harbored by many species of animals which serve as reservoir hosts. Immature ticks transmit the disease between animals and man. Adult ticks also may be involved.

The state has a great diversity of tick and animal species that may harbor the organism causing Lyme Disease. Based on the great number of residents and tourists who visit outdoor South Carolina, Lyme Disease has the potential to be a major threat to health and well-being of a large segment of our population.

Current research consists of a statewide survey to determine the tick species presence and their geographical distribution, the incidence of infection among ticks in South Carolina, survey of reservoir hosts to determine which might play a major role in the epidemiology of the disease, and to interact with the medical community to develop strategies for controlling the spread of this disease.

Evaluation of ovicides against bollworms on cotton revealed that Larvin, Ovasyn, Curacron, Scout, Baythroid and Lannate were effective compared with the standard, chlordimeform. Economic threshold studies for bollworms on cotton demonstrated that season-long scheduled insecticide applications were not economically justified compared with applications based on scouting reports. Studies are being conducted to determine if selected bollworm egg thresholds are superior to thresholds based on larval populations and damage. Monitoring techniques were developed for selected pest and beneficial insects on cotton. Research is in progress to define and quantify the parameters needed for development of a European corn borer management model. A predictive equation based on maximum-minimum temperatures was developed for European corn borer spring emergence.

### Experimental Statistics

The Experimental Statistics Department teaches graduate and undergraduate students and provides a statistical consultancy for research scientists and their graduate students in the Experiment Station. Experimental Statistics has achieved departmental status, thus accomplishing a long-term goal.

The faculty, through individual and collaborative research, has contributed to more than 80 research publications.



A research proposal, "Control of Spread on Nonpersistently Transmitted Viruses by Interference with Aphid Vector Behavior," submitted to the United States-Israel Binational Agricultural Research and Development Fund, in collaboration with the Plant Pathology Department, the Volcani Center and the USDA-ARS in Charleston, was successful. This BARD grant is for \$210,000 over three years.

The department is doing work on quantitative genetics in biotechnology at Clemson and is in consultation with a private research firm.

## Food Science

Biotechnology is being utilized to identify viruses or bacteriophage that might be used to transfer desirable genes into or between members of the industrially significant Lactobacilli. Three strains of the intestinal species, *L. acidophilus*, whose genes might harbor the genes of bacterial viruses have been indentified. These strains were treated with a mutation-causing agent that induces the production of many copies of virus genes. It's significant that no bacteria that were attacked by the virus or that might be candidate recipients of any genes that it carried were identified. It has further been observed that a culture of *L. acidophilus* that carries the virus genes when treated by methods that prevent the reproduction of viral genes no longer burst after treatment with the mutation-causing agent and were attacked by the virus. The results suggest that these strains had lost the virus genes. Genes from the virus were chemically labeled and were reacted with genes of the *L. acidophilus* culture carrying the virus. The labeled genes reacted with genes of the virus-carrying culture but not with genes of culture thought to have lost the virus. These results prove that the virus can be eliminated from strains of *L. acidophilus*. These studies are bringing nearer the development of viral gene transfer systems in the lactobacilli, a genus that is responsible for the production of tens of billions of dollars of foods and animal feeds annually.

Using laboratory rats as the test animal, bone densitometry studies are under way to determine changes in bone that occur in growing laboratory rats fed low, marginal or adequate levels of dietary calcium. Mean femoral densitometry values for rats fed low calcium diets were 45 percent lower than values for rats fed an adequate calcium diet. Bone densitometry values also correlate with the histological measurements of the bone. Bones from rats fed low-calcium diets were more poorly mineralized and had a higher medullary cavity area than rats fed an adequate-calcium diet. These data are consistent with differences in bone density among rats fed low-calcium or high-calcium diets. Studies continue with the objective of providing information to permit dietary treatment that will significantly reduce the incidence of human osteoporosis.

Packaging scientists are working to extend the quality shelf life of fresh foods by controlling the atmosphere of the packaged product through the use of specialized films. Results show that selected packaging films, particularly those with moderate oxygen transmission rates, can safely extend the shelf life of shredded cabbage, especially when compared with high-oxygen transmission-rate films. Extended shelf life was obtained when the product is held at relatively high temperatures. However, when films with low-to-moderate oxygen transmission rates were used, fermentation, off-odors and conditions favorable to the growth of pathogens were observed. Research continues



with a focus toward optimizing the film/temperature/atmosphere combinations necessary to safely extend the shelf life of foodstuffs.

The development and application of metallic membrane microfiltration of whey to replace chemical and physical pretreatments prior to ultrafiltration and spray drying of whey protein concentrates has yielded important results. Studies suggest that metallic membrane microfiltration appears to be more effective than chemical pretreatment for removing lipoproteins and other lipids from the whey when based on the improved ultrafiltration flux rate, turbidity and preliminary chemical data. Studies are under way to evaluate the influence of spray drying on the physicochemical and functional properties of whey protein concentrates prepared from metallic membrane microfiltered whey.

### **Home Economics**

A three-part benchmark data project funded by the Fulbright Commission and several organizations in South Carolina and Scotland is designed to document what percentage of South Carolina homes have moisture problems and the causes of the problems.

Data indicate that 50 percent of the sample houses in the first part of the study had moisture damage. Further data from more than 1,600 homeowners and pest control operators are being studied.

Research was begun to develop a protective garment that can be worn during pesticide application, particularly air blast spraying. Researchers are working with several nonwoven fabrics made of wood pulp such as SMS, Sontara and Tyvek. These fabrics are highly flammable. The flame retardant and the fluorocarbon, which protects against pesticide contamination, have offsetting effects on each other. Researchers want to find the proper combination for both of these components. Data are being collected from the field testing of the suit.

### **Horticulture**

A competitive grants program was established to encourage interdisciplinary research in ornamental horticulture. Twenty-seven investigators prepared proposals seeking a total of \$622,106 over a three-year period. Five proposals were funded in the areas of mechanizing micropropagation, greenhouse optical filter technology, genetic analysis of roses using recombinant DNA techniques, herbicide resistance screening, and gel technology for agrichemical delivery to ornamental plants. More than \$210,000 will be invested over three years, with faculty from several departments in the colleges of Agricultural Sciences and Sciences participating.

Researchers from the Horticulture and Agricultural Engineering departments are investigating the effects of light quality on growth of horticultural crops. Reflective-colored plastic mulches are used to vary the light color around field-grown vegetable crops and greenhouse-grown ornamental crops, while various dyes are used in a prototype liquid filter system to vary the color of light entering a greenhouse. Initial results indicate that the color of light affects yield of tomatoes, severity of whitefly infestation on greenhouse ornamentals, and height of crops grown in greenhouse compartments under colored filters.



Horticulturists continue to develop improved breeding lines to introduce new crop varieties for state producers. Several advanced selections of peaches are being evaluated in grower orchards with anticipated release within one or two years. Advanced selections of orange-fruited tomatoes are being field tested, as is a very promising selection of watermelon.

The tissue culture laboratory has been completed and now facilitates the research of several scientists. A new variant *Rhododendron* was discovered and will be released. Variation induced during tissue culture will be exploited to improve varieties of tomato and watermelon. Researchers in Horticulture and Agricultural Engineering are developing mechanized handling systems to increase efficiency in tissue culture propagation. Other research in the tissue culture area involves somatic embryogenesis studies on tomato and watermelon, long-term storage of sweet potato germplasm and genetic transformation systems for cucumber.

Improved vegetable production systems continue to receive high priority. Leaf cupping and marginal tipburn symptoms that reduce marketability of collards were identified as a calcium deficiency, and a Clemson researcher documented differential cultivar sensitivity to calcium levels. The problem was alleviated by foliar applications of calcium.

The potential for off-season production of asparagus is being studied. Acceptable yields are obtained July to September, although these are somewhat lower than the normal March to May season. Alternative production of broccoli for the processing industry is also under study. Herbicide systems for vegetable crops have improved yields. Sublethal rates of chlorimuron and imazaquin, however, reduced growth and yields of cucumber, sweet potato and snapbeans. Further research must be conducted to adapt currently available herbicides to vegetable crop production systems.

In fruit crops research an Asian pear test planting that includes 13 cultivars has been established at the Musser Farm. This planting is part of a regional evaluation that includes 11 sites in seven states. The purpose of the test is to determine the feasibility of commercial production in this region through evaluation of insect and disease pressure. Severity of fireblight infection is a prime concern. Additionally, 12 peach rootstocks budded with Redhaven and Springcrest scion cultivars were established on a non-fumigated test site with high activity of peach tree short life. This is part of an ongoing effort to identify a source of resistance or tolerance to the economically devastating peach tree short life problem.

### **Plant Pathology and Physiology**

The Plant Pathology and Physiology Department is responsible for developing basic knowledge that will assist with formulating controls for plant diseases and disorders. Plant diseases are caused by many kinds of organisms and environmental conditions. Causal agents of concern in South Carolina include bacteria, fungi, viruses and nematodes. Only a small percentage of the organisms are harmful. Separating the good ones from the bad ones is part of plant disease diagnosis, as is determining how some of the good ones can be used to control bad ones. Pesticide effectiveness, action and fate in the environment also are projects on which our researchers work.



There are a number of ways to control a plant disease. Pesticides are a primary control method. Rotations and other cultural practices are appropriate methods for limiting the effects of plant diseases. Resistant varieties are used extensively to lessen the impact of harmful microorganisms.

Meloidogyne arenaria race 2 is a peanut root-knot nematode for which there is little resistance. After a five-year study it was found that the nematode increased on all tested varieties of tobacco and soybeans. Cotton, corn and peanuts were not attacked by this nematode very well. Therefore, rotations utilizing cotton, corn or peanuts before soybeans and tobacco will help control the peanut root-knot nematode. Companion research showed that some nematicides generally thought to be broad spectrum actually favor a build-up of *M. arenaria* such that the following crop may be severely damaged. Resistance to *M. arenaria* has been observed in some tobacco plant introductions.

The Columbia lance nematode was found to damage all varieties of cotton tested. It also was found that dichloropropene treatments resulted in 5-10 percent yield increases.

Environmental concerns associated with placing pesticides and genetically altered organisms were addressed. Under anaerobic conditions, diquat was reduced in as little as 19 days. Diuron and trifluralin remained unchanged after 157 days. Propanil was converted rapidly, and 4-chlorophenol was completely degraded to carbon dioxide and other similarly constructed chemicals during the same time period.

There was limited movement of a genetically engineered organism placed in rows planted to wheat. The farthest movement was seven inches. This strongly suggests that the native populations of microorganisms compete very well with introduced populations. On the other hand, there were laboratory results that showed that certain soil insect larvae can ingest the genetically altered bacteria and that the bacteria will stay in the insect gut until adult insects emerge. Genetically engineered root-colonizing bacteria were able to enter natural wounds and openings in the root system and move into the foliar regions of the plant.

## Poultry Science

Research expertise in the Poultry Science Department encompasses housing, immunology, nutrition, physiology, (products), management and pathology. We have harnessed this expertise, in part, by forming an umbrella-type molecular research initiative called immuno-enhancement of the embryo. While this is only a part of the research effort in the department, this initiative has offered direction and stimulated discussion in all areas of research.

Isolates from turkey semen have revealed a cell that may play an important role in the immuno-physiology of the vertebrate. The cell, a spermiophage, destroys particle substances and thus is an important arm of the immune system. The mechanism the cell employs is unique to the vertebrate system. A caveat to the protective role of the spermiophage is its possible contribution to the clumping of spermatozoa that have been removed for artificial insemination. The removal or inactivation of these cells might extend the life of spermatozoa in the test tube.



Poultry are susceptible to fowl cholera, *Pasteurella multocida*. A DNA library of *Pasteurella* has been developed. Antibodies against whole *Pasteurella* detected activity in several DNA segments. These are the first observations that could lead to the identification of the optimum antigens for protecting poultry.

Cells secrete factors, which influence the animal's ability to respond to the environment. Bioassays are being developed to identify these cells and their factors. Factors called interleukins have been identified in mice and humans. Several of the interleukins have been demonstrated in the department. Poultry is unique in possessing two sites for the study of cells specialized in contributing to the immune system. The Harderian Gland, located in the eye orbit, is unique in its possession of plasma cells or antibody-producing cells. These antibody-producing cells have been shown to progress through different cellular stages and are being studied for their response to interleukins. A second unique gland is the bursa of Fabricius in which the antibody repertoire develops. Monoclonal antibodies have been raised against cell preparations containing a unique cell of the bursa, a dendritic cell. The monoclonal antibodies are being used to screen tissues for the location of dendritic-like cells. These cells are being purified to study their role in interleukin production.

Experiments designed to study environmental influences on embryo and neonatal development have demonstrated a detrimental effect of cooling on leukocyte development of embryos but not embryo growth. Chemical changes in the presence of stress have been a major concern of vertebrate physiologists. Specific amines and nucleotides are being studied in the search of a chemical marker that will aid in the evaluation of stress.

### **Research and Education Centers**

The S.C. Agricultural Experiment Station's four research and education centers continue to stress the specialties of the areas in which they are located.

### **Coastal Research and Education Centers**

The primary responsibility of the Coastal Research and Education Center is to develop efficient and economical systems for commercial vegetable production in South Carolina. A primary goal is to become a center of excellence for vegetable research.

Some of the major research activities include growing asparagus out of season in the Coastal region. Highest yields came during normal spring harvests, but asparagus of acceptable volume and quality was harvested in July. Economic analysis of income potential showed that gross incomes were equivalent to or greater than harvests forced from July to September in contrast to those from normal spring harvest.

Tomato transplants, nutritionally conditioned during greenhouse transplant production with high nitrogen and phosphorous fertility, produced higher overall yields than plants fertilized using commercial practices. This research provides new guidelines that establish the level of transplant quality state growers must demand to ensure highest yields.

Broccoli research has indicated that fresh-market, high-quality broccoli can be produced in spring as well as fall in the Coastal region. Broccoli for the floret market



also can be produced throughout the summer. Varieties are being evaluated for heat tolerance, and some have been identified.

The most important insect pest of collards at the Coastal facility was the imported cabbageworm *Pieris rapae*. Other species of caterpillars were present but not at economically important densities. In farmers' fields in Lexington County, cabbage loopers and diamondback moth were most important. Experiments are being conducted to quantitatively assess the role of numerous beneficial species identified and determine the impact of chemical insecticides on their production.

Chemical insecticides are grossly overused by most commercial growers in core crops. In field tests for the control of foliage-feeding caterpillars, several microbial insecticides provided adequate control of these pests. Use of microbial agents will avoid insecticide resistance, conserve naturally occurring biological control agents and avoid environmental contamination. More tests are planned using bioengineered *Bacillus thuringiensis* and transgenic tomato plants containing the BT gene.

Concerns about environmental contamination from packingline wastewater promoted a study in the fall of 1988 to detect chemical residues. All state tomato packers participated in the study. Organic pesticides were detected in packinghouse dump tanks within two hours of operation. Data from this study will provide packers information needed to make sound management decisions about the disposal of wastewater. This study is being conducted in cooperation with the Agromedicine Program of the Medical University of South Carolina.

A market for S.C. watermelon is gradually being developed in Europe. Loads of melons have been shipped from the port of Charleston to England with some success. However, melon quality on arrival could be improved. Studies have been initiated to monitor ethylene sensitivity and chilling susceptibility of different melon varieties. New packingline techniques are being evaluated for their effects on storage quality.

Today's emphasis on novelty in the marketplace is leading to the development of new tomato varieties in "designer" colors at the Coastal facility. The first tangerine-colored tomatoes will be tested on state farms during spring 1990. They are very firm and meaty, but retain good flavor. Crimson, orange, yellow, pink and apricot varieties are still in the development stage.

### **Edisto Research and Education Center**

Edisto Research and Education Center stirred interest around the world during fiscal year 1988-89 as researchers completed a historic test of the first microorganism containing genes from two separate sources to be placed into a field environment.

This joint project between Monsanto Co. and Clemson University was an evaluation of a biological tracking system for microorganisms introduced into the soil. The genetically engineered system worked perfectly, with the organism — a strain of the common soil microorganism *pseudomonas fluorescens* — staying within a narrow zone on wheat roots.

A follow-up test of a similar organism, with the Monsanto tracking system inserted, was conducted on wheat planted in the fall of 1988. The organism, which has shown control activity against wheat take-all disease, was tracked throughout the growing season. The test is now being evaluated.



A system for injecting propionic acid and other preservatives into high-moisture hay was developed and tested under field conditions. The system, which can be attached to small balers, one day may enable farmers to reduce hay losses when humidity is high.

A team of agricultural engineers and agronomists continued to refine a system for interseeding soybeans and cotton into standing wheat, taking advantage of spring moisture rather than waiting until after wheat harvest to double crop during the dry days of June and July.

Entomologists at Edisto have been exploring the effectiveness of biological insecticides for controlling pests on cotton and soybeans. Several strains of *Bacillus thuringiensis* are being evaluated for activity against *heliiothis*. Researchers are looking at whether the BT gene can be counted on throughout the growing season or whether it is limited to early season use.

Considerable effort was made to find alternative crops for the region. Two that look promising are canola and flax. A regional workshop on canola attracted participants from a number of states and Canada. Yields were good on the canola plots, but planting dates need to be explored before flax can reach its potential.

The 1988-89 year also saw construction begin on new cattle handling facilities and remodeling of the station shop to meet state certification standards.

Planning began during the year on a new facility combining offices, laboratories and an auditorium to replace facilities constructed more than 50 years ago and a temporary office-lab building completed in 1985.

### **Pee Dee Research and Education Center**

Scientists working in tobacco have tested five new lines being released to the public along with nine new lines that will be advanced for further testing. Progress continued on the development of a line resistant to the "peanut" root knot nematode, with more than 600 lines screened for resistance and 51 lines tested for potential release. Evaluations were made on 800 tobacco lines for resistance to certain insects. Two new chemicals were evaluated and show promise for aphid control and control of budworms and hornworms.

A five-year rotation study in a nematode-infested field was completed. It showed lowest yields where continuous tobacco or a soybean rotation was used. The best rotational crops were corn, cotton or peanuts.

Curing models were developed to determine air flow characteristics in bulk barns and should help growers detect problem areas and lead to better quality tobacco.

Cotton investigations have resulted in the development of 24 germplasm lines for release for insect resistance, yield potential and fiber quality. Crosses using PD lines and lines from the Delta area were evaluated for early and late plantings at several locations. Several new chemicals were evaluated for improved insect control.

Scientists working with corn found starter fertilizer to increase yields when nitrogen and phosphorus were used and conditions were favorable for yields that exceeded 150 bushels per acre. Studies of the European corn borer were conducted to determine the degree of parasitism and predicted days of emergence. Alfatoxin studies concluded that overhead irrigation decreased leaf canopy temperatures as well as alfatoxin infestations. Nematicides applied to the soil greatly increased corn yields.



Vegetable research showed increased yields and quality of watermelons using various forms of nitrogen. Studies with Cayenne pepper indicated closer spacing will aid in a more efficient mechanized harvest. Progress continues on the use of a retrofitted tobacco harvester to be used in vegetable production.

### **Sandhill Research and Education Center**

The mission of the Sandhill Research and Education Center is to conduct research and extension programs in fruits, vegetables, ornamental crops and swine.

Peach tree short life (PTSL) work continued this year. Ten *Prunus* families were selected and propagated from an initial field screening of 143 *Prunus* lines tested on a PTSL site. These potential rootstocks were budded with Redhaven and Springcrest and planted on a severe PTSL site. Survival of one peach and one plum line looked especially promising when compared with the commercial standard Lovell.

A study comparing orchard middles of Pensacola bahiagrass and clean cultivation showed that cultivation increased yield by 20 percent in the first harvest year, but decreased fruit soluble solids by .5 percent and delayed fruit maturity.

A two-year study of the frost protectant "Frost Free" showed that it significantly increased vegetative growth of fruiting wood and slightly increased fruit yield.

The Peach Certification project produced 100,000 finished virus-free trees this year and 6,000 pounds of seed. Approximately 20 percent of new peach trees planted in South Carolina in 1989 came from seed and budwood stock produced by the Sandhill facility.

Leaf cupping of collards under high temperature stress was identified as a problem in Lexington County during the summer of 1988. Nutrient analyses of leaf samples from growers' fields indicated that the leaf cupping was caused by a localized calicum deficiency in the leaf tip. Greenhouse and field studies confirm that the problem is related to calcium nutrition and that cultivars differ in their susceptibility to this disorder. Thirteen percent of the cultivar Vates were unmarketable due to leaf cupping, whereas the cultivar Blue Max did not have any unmarketable plants.

Ornamental research efforts include root development studies, weed control, irrigation and festigation projects with field-grown nursery stock. Studies with container-grown plants include weed control, nutrition and water management.

Additional studies with both field- and container-grown nursery stock involve co-operative efforts with Clemson's Entomology and Plant Pathology and Physiology departments and grower and nursery sites throughout the state.

In 1987 the S.C. Swine Test Station at the Sandhill facility began testing four groups of boars per year instead of two. This was done by producer and Clemson personnel agreement in an effort to maintain testing numbers and the supply of performance tested boars for commercial producers. The preceding four years saw more than a 50 percent decline in the number of active purebred breeders in the state due to economic hardships in the commercial sow production.

The Sow Productivity Indexing (SPI) program has been an extremely useful tool for commercial hog producers. Currently, more than 3,000 sows are on the records program.

On-farm testing of purebred swine increased from 1,264 head to 1,474 boars and gilts last year.



## **Active Research Projects 1988-89**

### **Agricultural Economics and Rural Sociology**

Monetary, fiscal and trade policy impacts on farm organization.

Socioeconomic dimensions of technological changes, natural resource use and agriculture structure.

Organization and operation of S.C. water utility systems.

Growth of the S.C. broiler industry relative to other Southeastern states and the United States.

Agricultural adjustment in the Southeast through alternative cropping systems.

Marketing strategies for agronomic crops with uncertain prices and yields.

Economic analysis for coastal resources management and policy.

Demographic data analyses and policy implications.

Analysis of the farmland market in South Carolina.

Rural entrepreneurship: assessment of its potential as a rural development strategy.

Analysis of structural and organizational changes in rural counties in the South.

Changing patterns of food demand and consumption behavior.

Potential for community economic development and its impact on rural residents.

Analysis of economic costs and benefits of the U.S. sugar program.

Economic and technical forces shaping the Southern dairy industry.

Competition and change in the fruit and vegetable production and marketing system.

Agricultural adjustment in the Southeast through alternative cropping systems.

Econometric analysis of yields of major agronomic crops in South Carolina.

Changing structure of local labor markets in non-metropolitan areas.

Quantifying long run age risks and evaluating farmer responses to risk.

International trade research on commodities important to the Southern region.

### **Agricultural Education**

Labor force experiences of persons trained in colleges of agriculture.

### **Agricultural Engineering**

Optimize production efficiency of animal housing systems in the Southern region.

Processing and storage of Southern agricultural commodities.

Engineering and management systems for cotton production, harvesting and processing.

Engineering analysis and design for aquaculture of catfish, crawfish and clams.

Animal waste as nutrient and energy resources in warm, humid climates.

Automatic monitoring and controlling grain storage.

Remote sensing and sensor development for tree fruit production and harvesting.



Electronic sorting and grading of fruit for quality and maturity.  
Engineering systems for plant tissue culture.  
Automatic control of field machine functions for increased efficiency and energy conservation.  
Compost for control of apple collar rot.  
Hydrologic/water quality modeling of sediment and chemical movement.  
Low-cost, multi-purpose vegetable production machine/system.  
Modification and evaluation of a harvester prototype for small-stature, high-density peach trees.  
Control prediction, economics and environmental effects of soil erosion.  
Agricultural application of machine vision system.  
Dynamic modeling of water quality in aquaculture.  
Edible films from cereal grains and soybeans.  
Hydrogeology of unsaturated piedmont saprolite.

### **Agronomy and Soils**

Grain yields and field performance of barley, oats, rye and wheat.  
Advanced strains and cultivars of cotton, soybeans and peanuts.  
Field corn and grain sorghum cultivars for grain production.  
Development of improved soybean varieties.  
Chemistry of atmospheric deposition: effects on agriculture, forestry, surface waters and materials.  
Life history, population dynamics and interference: a basis for understanding weed biology.  
Growth and nutrient uptake by soybean roots as affected by cultivars and soil properties.  
Breeding cool season forage grasses.  
Establishment and management of forage crops under stresses of environment and biotic origin.  
Characterizing plant traits for improved crop performance.  
Mineralogy of selected soils in the Southern region.  
Environmental tracking of a LacZY-engineered natural soil bacterium.  
Weed control and herbicide resistant weeds in corn, cotton and soybean.  
Effect of soil test values and fertilizer amendments on the nutrient content and yield.  
Enhancing beneficial microorganisms in the rhizosphere.  
Variability of soil properties and its effect on water quality and soil management.  
Cellular and molecular genetics for improvement of maize and fescue.



## **Animal Science**

Nutrition and management of swine for increased reproductive efficiency.  
Effect of gender and feed intake on growth and serum hormones and metabolites of the bovine.  
Improving reproductive efficiency of cattle and swine.  
Endocrine mechanisms during pregnancy in the cow.  
Physiology of pregnancy and embryo survival.  
Forage components that influence nutrient digestion and metabolism in ruminants.  
Genetic potential of beef cattle for forage utilization.  
Genotypic evaluation of Zebu and British-Continental cattle.  
Development of profitable beef-forage production systems for the Southern Region.  
Genetics of body composition in beef cattle.

## **Aquaculture, Fisheries and Wildlife**

Biology of clams, whelks and other important shellfish.  
Juvenile white-tailed deer dispersal and movement behavior.  
Eastern bluebird home range and habitat use.  
Lake Moultrie creel survey.  
Canada goose nesting biology and gosling survival on farm ponds.  
Delta waterfowl and wetland research station — Atlantic Flyway Station.

## **Biological Sciences**

RFLP and molecular analysis of root knot nematodes, nematode-infected plants and peaches.

## **Dairy Science**

Dietary factors affecting the toxic and immune response of ruminants to mycotoxins.  
Optimizing nutritional management of dairy cows.  
Effects of aflatoxin B-1 on bovine and avian T-cell function in vitro.  
Bovine somatotropin (BST) in lactating dairy cows and concentration in dairy foods.  
Use of carbon dioxide in frozen dairy-based desserts.  
Effects of defined serum replacements and growth factors on cultured ovine and bovine embryos.  
Rapid determination of milk shelf life using antibodies to spoilage bacteria.

## **Entomology**

Entomopathogens for use in pest management systems.  
Identification and distribution of insects of potential importance in South Carolina.  
Biology and control of arthropod pests on apples.



Population dynamics and management of peach arthropods.  
Areawide population dynamics and ecology of the corn earworm.  
Management strategies for insect pests of alfalfa.  
Development biology of polyembryonic parasitoids.  
Management and biology of arthropod pests of livestock.  
Biology, ecology and control of selected cockroach and termite pest species.  
Integrated management of cockroaches in structural and industrial environments.  
Control of selected insects and mites attacking ornamental trees and shrubs.  
Improved systems of control for pecan arthropod pests.  
Behavioral relationships of selected pest and nonpest Lepidoptera.  
Biology and management of filth flies and other arthropod pests.  
Black fly damage thresholds, biology and control.  
Behavioral and control studies of red imported fire ant.  
S.C. participation in NAPIAP.  
Cloning and analysis of genes for insecticide resistance.

#### **Experimental Statistics**

Statistical computer methodology for research planning and analysis.

#### **Food Science**

Functional properties of food proteins.  
Shelf life and quality of individually shrink-wrapped fruits and vegetables.  
Plasmid and genetic transfer systems in lactobacilli.  
Protein and mineral bioavailability from food products.  
Dietary zinc and changes in bone composition.  
Development of new processes and technologies for the processing of poultry products.  
Trace mineral bioavailability studies in plant proteins utilizing protozoa.  
Product development for increased utilization of the sweet potato.  
Immobilization of cells and enzymes on metallic membranes for production of food components.

#### **Home Economics Extension**

Moisture damage in South Carolina housing.

#### **Home Economics Research (cooperative with Winthrop College)**

Nutritional status and body composition of normal-weight, middle-age females.  
Textile fiber systems for performance, protection and comfort.



## **Horticulture**

Plant germplasm — its introduction, maintenance and evaluation.

Chilling injury of selected greenhouse plants.

Nitrogen and water application practices for ornamentals and turfgrasses.

Quality maintenance and improvement of fresh-market peaches and apples.

Herbicide phytotoxicity, morphology and early disease detection in turfgrasses.

Improving plastic mulch and row cover crop systems for vegetable production.

Weed management in cucurbit crops.

Temperature effects on growth and flowering of kiwifruit.

Extending shelf life of floricultural crops by manipulation of postharvest environment.

Rapid herbicide screening techniques for ornamental crops.

Improved production of greenhouse crops using optical filter technology.

RFLP analysis and DNA fingerprinting in rose cultivars.

## **Plant Pathology and Physiology**

Forage legume viruses.

Biochemical and residual properties of pesticides.

Biological and chemical control for nematodes and diseases of peach and apple trees.

Causes and control of diseases of woody ornamental plants with emphasis on camellias.

Herbicide resistance and metabolism in tissue culture.

Causes and control of diseases of cereal grains with emphasis on powdery mildew of wheat.

Disease etiology and resistance in southern pea and other vegetables.

Physiological indicators of stress in peach trees affected by peach tree short life.

Biology of genetically changing root knot and cyst nematodes of soybeans.

Distribution, ecology and pathogenicity of root knot nematode.

Control of peach tree short life in South Carolina.

Characterization of brown patch on centipede and St. Augustine grass in South Carolina.

Physiology and molecular genetics of selected plant-bacterial interactions.

Virus and virus-like diseases of woody, deciduous fruit crops.

Forage legume viruses: identification and genetic resistance for improved productivity.

## **Poultry Science**

Nutritional and hormonal factors influencing structure and quality of eggshells.

Control of food and water intake in poultry.

Monitoring fowl cholera immunity in turkeys.

Factors affecting the ability of the hen to sequester sperm.



Improved detection and bacterin efficacy of turkey mycoplasmosis.  
Reproductive efficiency of turkeys.  
Amylases in chickens: molecular basis and effects on growth rate.  
Function of a secretory cell, a Dendritic cell, of the bursa of Fabricius.  
Genetic relationships to growth and reproduction in diverse poultry populations.  
Effects of cooling avian embryos: immunocompetence and stress.

#### **Coastal Research and Education Center**

Urban horticulture for Coastal South Carolina.  
Breeding fresh-market tomatoes for bareground unstaked production.  
Storage potential of selected S.C. vegetables using modified atmosphere packaging.  
Production potential of summer- and fall-harvested asparagus in Coastal S.C.  
Nutritional conditioning, temperature and water stress at transplanting on tomato.

#### **Edisto Research and Education Center**

Assessment of progress in breeding for soil-pest resistance in sweet potatoes.  
Breeding soybeans for resistance to insect and nematode pests.  
Genetic mechanisms for soybean germplasm development.  
Breeding and evaluating sweet potatoes for food and industrial uses.  
Agronomic evaluation of quality forages in the S.C. coastal plain.  
Engineering improvement and management of forage harvesting and conditioning systems.  
Breeding of watermelon and evaluation of muskmelon varieties.  
Physical and chemical characteristics of forages and their relationships to forage quality.  
Propagation, hybridization and selection schemes for the improvement of sweet potato and cucurbits.  
Arthropod-induced stress on soybean: evaluation and management.  
Management of *Hoplolaimus columbus* nematode on cotton and soybean.  
Endemic and imported natural enemies of soybean and cotton insect pests.  
Insect management in reduced-cost cotton production systems.  
A new reduced-tillage, wheat-soybean intercropping system for South Carolina.

#### **Pee Dee Research and Education Center**

Suppression of aflatoxin and nematodes in corn through cultural practices.  
Tobacco disease and nematode control.  
Cultural practices and variety development for flue-cured tobacco.  
Economic management of tobacco insect pests.



Impact of integrated crop management practices on European corn borer and related stalk-boring insects.

Bionomics and control of insects on cotton.

Effect of European corn borer population density on injury to corn.

Tobacco curing models for maximizing efficiency in bulk box barns.

Cotton breeding for improved quality, insect resistance and production efficiency.

Breeding disease and *Meloidogyne arenaria* resistant flue-cured tobacco.

### **Sandhill Research and Education Center**

Environmental and biological stresses of rootstocks in peach tree longevity.

Trickle irrigation in humid regions.

Cultural and management practices of pecans.

Rootstock and interstock effects on peach physiology.

Production systems for cool-season vegetable crops.

Viruses and viral diseases of peach.

Technical and economical efficiencies of producing and marketing landscape plants.

Hydrophilic polymers for enhancement of agrichemical delivery systems in ornamental crop production.

### **Technical Contributions**

- 2855 CONCURRENT TEMPORAL DISTRIBUTION OF ALDICARB IN THE SOIL SOLUTION AND FOLIAGE OF PECAN AS RELATED TO APPLICATION METHODOLOGY AND WATER MANAGEMENT by Jonathan A. Hornby and David R. Alverson.
- 2856 ADDITIONAL HOSTS FOR THE RING NEMATODE, *CRICONEMELLA XENOPLEX* by E.I. Zehr, J.B. Aitken, J.M. Scott and J.R. Meyer.
- 2857 TISSUE AND CELL CULTURES AS MODEL SYSTEMS IN HERBICIDE RESEARCH by N. Dwight Camper and Sandra K. McDonald.
- 2858 EXCLUSION OF INEFFICIENT *BRADYRHIZOBIUM JAPONICUM* SERO-GROUPS BY SOYBEAN GENOTYPES by G.C. Weiser and H.D. Skipper.
- 2859 STUDIES ON CYLINDROCLADIUM BLACK ROT (CBR) OF CAMELLIAS by L.W. Baxter, Jr., and S.B. Segars.
- 2860 EFFECT OF INDIVIDUAL SHRINK-WRAPPING ON SHELF LIFE, EATING QUALITY AND RESPIRATION RATE OF TOMATOES by S.R. Bhomik and G.J. Hulbert.
- 2861 SERUM IUTEINIZING HORMONE, PROLACTIN AND ANDROGENS DURING SEMEN COLLECTION IN EXPERIENCED AND INEXPERIENCED TOMS by G.P. Birrenkott and J.A. Proudman.



- 2862 FACTORS FAVORING MATERNAL CARE IN THE GREEN LYNX SPIDER, *PEUCETIA VIRIDANS* (HENTZ) (ARANEAE: OXYOPIDAE), WITH SPECIAL REFERENCE TO PREDATION by Marianne B. Willey and Peter H. Adler.
- 2863 RECIPIENT BREED EFFECT ON BIRTH AND WEANING WEIGHTS OF HEREFORD EMBRYO TRANSPLANT CALVES by J.K. Rogers, Jr., C.E. Thompson, Craig Ludwig and W.C. Bridges, Jr.
- 2864 COMPARISONS OF PATTIES USING MIXTURES OF GROUND MEAT FROM BEEF, PORK AND CHEVALINE by T.V. Eades, T.M. Moore, R.G. Godbee, E. Halpin and G.C. Skelley.
- 2865 ACCEPTABILITY, SHRINKAGE AND MICROBIAL GROWTH OF VACUUM PACKAGED PORK COMPARING INTACT PACKAGES, LEAKING PACKAGES AND ROASTS SPRAYED WITH SODIUM HYPOCHLORITE by Gonzalo Fandino, George C. Skelley and Dale L. Handlin.
- 2866 PRUNUS NECROTIC RINGSPOT VIRUS IN PEACH ORCHARDS OF SOUTH CAROLINA by S.W. Scott, O.W. Barnett and P.M. Burrows.
- 2867 GENETIC TRENDS FOR YOUNG SIMMENTAL SIRES SAMPLED FROM 1978-1987 by J.K. Rogers, Jr., C.E. Thompson, R.E. Chrestman, M.A. Worrell and W.C. Bridges, Jr.
- 2868 A STUDY OF THE SOURCE OF ESTRADIOL-17 IN THE BULL by D.M. Henricks, J.L.B. Hoover, T. Gimenez and L.W. Grimes.
- 2869 UPGRADING A POULTRY PROCESSING PLANT WASTEWATER TREATMENT SYSTEM by Richard K. White.
- 2870 INFLUENCE OF PREHARVEST FACTORS ON POSTHARVEST QUALITY OF PREPACKAGED FRESH MARKET SPINACH by Jon R. Johnson, Janice R. McGuinn and James W. Rushing.
- 2871 MOBILITY LIMITATIONS OF BOUND POLYGALACTURONASE IN ISOLATED CELL WALL FROM TOMATO PERICARP TISSUE by James W. Rushing and Donald J. Huber.
- 2872 EGG-HATCHING BEHAVIOR OF *HELIOTHIS ZEA* AND *H. VIRESCENS* (LEPIDOPTERA: NOCTUIDAE) by Peter H. Adler and Charles I. Dial III.
- 2873 TOXICITY OF PERCOLATE FROM DECONTAMINATED PESTICIDE-CONTAMINATED SOILS by J.W. Foltz.
- 2874 SOME THOUGHTS AND A NEW OBSERVATION ON CAMELLIA DIEBACK AND CANKER by Luther W. Baxter, Jr., Sally B. Segars and Susan G. Fagan.
- 2875 ALTERNATIVE MATERIALS FOR CONTROL OF FENVALERATE RESISTANT HORN FLIES (DIPTERA: MUSCIDAE) IN SOUTH CAROLINA by W.E. Barton, R. Noblet, C.E. Thompson, J.C. Spitzer and H.S. Hill.
- 2876 CALCULATING CHILL HOURS AND CHILL UNITS FROM DAILY MAXIMUM AND MINIMUM TEMPERATURE OBSERVATIONS by D.E. Linvill.
- 2877 MINERALOGY AND WEATHERING OF SOILS IN THE BLUE RIDGE MOUNTAINS OF SOUTH CAROLINA by M.L. Norfleet and B.R. Smith.



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## COOPERATIVE EXTENSION SERVICE

For 75 years the Cooperative Extension Service, the educational outreach arm of the Clemson University Division of Agriculture and Natural Resources, has provided information and statewide continuing education programs that have made life easier and more enjoyable for every South Carolinian. The programs cover 16 disciplines relating to agriculture and natural resources, home economics, 4-H and youth development, and community development. In addition to general education information, special programs are included for limited-resource farmers and the economically disadvantaged.

Funded by federal, state and county governments, the Extension Service was created in 1914 as a nationwide system designed to carry education from land-grant universities to the people. Extension has worked closely with South Carolinians helping them build a better life through dissemination of practical, useful information within its assigned areas of responsibility.

During statewide observances of Extension's 75th anniversary this year, thousands of South Carolinians took part in open house programs at Clemson Extension offices in all counties.

Originally conceived to help rural people, Extension responded to the changing needs of those it served by broadening its scope of activities to include urban and suburban problems.

Clemson University, through its Extension Service, maintains an office manned by agents in each county. A professional staff of Extension subject-matter specialists at the University and four research and education centers around the state compiles information from research and translates it into information the people of South Carolina can use day-to-day.

From basic nutrition information to irrigation field tours, Extension staff members and volunteers are teachers carrying Clemson University educational programs to all areas of the state.

The Extension program is organized around these broad categories: agriculture and natural resources (including special programs for limited-resource farmers), 4-H and youth development, home economics (including the Expanded Food and Nutrition Education Program), community development and 1890 programs conducted by South Carolina State College in cooperation with the Clemson University Extension Service.

Recognizing that new educational programs and directions were needed to teach South Carolinians how to adjust to rapid technological, economic and social change, the Clemson Extension Service and the 1890 Extension program at S.C. State College began an intensive statewide survey in 1985 to determine what citizens of the state saw as today's most pressing problems.

Each Extension unit and county office took part in the survey, gathering information on demographics, economics, politics, technology and natural resources. Problem identification committees were formed in each county, and more than 1,000 South Carolinians listed 1,803 different concerns that needed attention.

These concerns were summarized and listed by priority. More than 5,000 people attended a series of advisory meetings around the state to review plans for solving these problems.



As a result of the statewide survey, the Clemson Extension Service and the 1890 program announced a four-year plan to tackle the concerns South Carolinians say are the most urgent. Twenty teams have been formed to design and implement programs to address each of the major areas of concern.

The teams began work in 1987. The plans of work for 1987 through 1991, put together by county and state Extension staffs and supervised by the program teams, are the result of the intensive statewide survey. To date the teams have organized and designed programs; trained Clemson Extension staff members in the counties; and evaluated the results of local programs.

Highlights of Extension activities within thrust teams and departments follow:

## **Advancing Agriculture and Natural Resources Management and Technology**

### **Agronomic Cropping Systems Management**

An interdisciplinary Extension team is being used to instruct farmers and agribusiness interests on the latest technological and scientific developments used in production, harvesting and marketing of agronomic crops. New teaching techniques are being implemented to reach more people more effectively with fewer resources. More emphasis is being placed on the use of practices that minimize potential adverse health and environmental impacts associated with crop production.

Tobacco, soybeans, corn, cotton, small grains, sorghum, forages and peanuts account for more than 75 percent of South Carolina's income from crops. A major goal of the Agronomic Cropping Systems Team is to increase the profit from production of these field crops. Increased producer use of recommended practices in fertilization, cultivar selection, crop enterprise selection, resource utilization and pest management is being emphasized. Adoption of these basic principles by farmers will increase profitability as well as provide healthier products and a cleaner environment.

Forage production for animal feeding is being revitalized by an educational program that provides sound data on management of production and grazing systems. Improved forage species are being used, weed and fertility management are receiving more attention, and grazing and haying practices are being made more efficient. The end results are greater quantity and higher quality feedstuffs being produced for a more efficient forage-cattle industry.

Production and marketing of row crops and small grains are organized around commodity teams, which are components of the systems team. The presence of well-trained, effective Clemson Extension Service personnel at the county level is a key component of this educational system. Specialists at the state level provide direction, but all programs move by and through the county delivery system.

County, multi-county and state meetings, tours and field days provided effective means for delivery of information dealing with new production and marketing practices. During the past year there were more than 150 such events held by the Agronomic Cropping Systems Team where more than 4,500 contacts were made. Publications were another important means of providing information for clientele. The team developed and disseminated 48 published documents dealing with crops. Short courses, training sessions, workshops and schools contributed to the educational effort, with 17 of these



events attracting 422 people. Eighty field demonstrations were used to show growers the results of new practices. Mass media efforts involving radio, television, videotapes, newsletters and news articles were made to 169 outlets by team members.

Notable program activities include the Statewide Corn-Soybean Expo where team members presented the latest pesticide recommendations for these crops to more than 200 growers and agribusiness people. The State Cotton Meeting emphasized efficient production and effective marketing. Plans to form a South Carolina cotton growers association were made, and Extension and research program needs were identified at this meeting by 160 persons. The State Tobacco Meeting was attended by more than 100 people who learned the latest developments in production and marketing of the state's top cash crop.

Cooperative efforts with the Water Quality Team are under way to minimize impacts of fertilizer and pesticides on water quality. The Land Resources Commission and Soil Conservation Service also participate in this effort.

The S.C. Department of Agriculture, Land Resources Commission, Soil Conservation Service and Clemson University have worked jointly to charter a S.C. Forage and Grassland Council to promote better production and grazing practices. These agencies are working to improve hay quality and establish a hay marketing system for South Carolina.

Contributing to national, regional and state stature of the team effort were 29 presentations made at professional meetings.

### **Aquaculture, Fisheries and Wildlife Management**

Through work with the S.C. Crawfish Growers Association, Clemson Extension Service agents and farmers, the S.C. crawfish industry increased acreage to 1,100 acres in 1989. Three softshell crawfish operations were developed by private growers with help from the Clemson Extension Service. Softshell production will increase the value of crawfish products from \$1.25 to \$8.00 per pound on the average. The first efforts at processing crawfish commercially in South Carolina began in 1989. Minimum orders for 100,000 pounds of prepared product have been pledged for the next five years. With help from the Clemson University-SCW&MRD Cooperative, shrimp aquaculture production exceeded 500,000 pounds and \$1,000,000 in value, ranking South Carolina third nationally in the production of marine shrimp. The S.C. Shrimp Farmers Association was formed for furthering South Carolina shrimp production through education, marketing and seed sources. The cooperative helped a local S.C. feed mill produce a shrimp feed which, if used by all farmers in the state, would save \$100,000. The local mill would gross an extra \$250,000, which would remain in South Carolina.

The Hampton Aquaculture Demonstration Center has just completed its first complete growing season. Fingerlings grown at the center have been stocked in 75 4-H projects across South Carolina as well as several home food production demonstration projects. A commercial catfish industry in the Hampton area is now a reality, with the majority of 1,000 acres of ponds proposed by Low Country Aquaculture Corp. already being stocked. The processing plant has been built and is being equipped. It can process 50,000 pounds per day.



Another center of catfish production is in Orangeburg where Limestone Fish Co. is prepared to process 1,000,000 pounds of fish stocked some months earlier—many in newly developed cage culture systems. To help aquaculturists, two new programs, Extension Economics Report 106 and 108, and the accompanying software have been placed in local Clemson Extension offices. These are designed to produce customized financial statements to facilitate financing.

An Extension wildlife program plan was prepared to address, in part, integrated wildlife and forest management systems. Activities completed include 1) the establishment of a 300-acre demonstration tract in McCormick County highlighting integrated wildlife and timber management on private land; 2) in-service training for 16 agents on wildlife management and marketing on private lands; 3) completion of three videos on habitat management and population management for deer and managing a hunting lease; 4) development of 4-H wildlife habitat program with training workshop held for volunteers leaders; 5) planning a symposium on fee-hunting on private lands in the South, which was held in July at Clemson; 6) general county programs on waterfowl management, managing and marketing wildlife, liability and hunting, quail management, deer management, and alternative income on private land; and 7) initiation of a waterfowl impoundment demonstration site on agricultural lands illustrating how land-owners can attract waterfowl and grow a profitable crop.

### **Dairy Management**

Dairy Extension education programs during 1988-89 centered around (1) educating producers on milk marketing, (2) use of computers in dairy herd management, (3) improving milk quality by reducing somatic cells, (4) improving dairy herd feeding programs, and (5) increasing the use of DHIA records.

Due to lower milk prices and high feed costs resulting from recent droughts, dairy producers have been in a tight financial squeeze for several years. Much effort is being made to change the way milk is marketed in South Carolina to ensure a more stable market. A federal milk marketing order has been proposed for the Carolinas. Many educational programs have been held by Clemson's dairy Extension specialists to educate producers on marketing options.

As dairy production becomes more technical, many producers have begun using computers. A computer publication was written and distributed, and several computer workshops were held in the state. These focused on (1) learning to use a computer, (2) using the DART ration balancing program, (3) using the DART program for dairy herd management, and (4) using a computer for financial management.

Dairy producers continue to improve their efficiency and production. During 1988 approximately 60 percent of the dairy herds in South Carolina were enrolled in the Dairy Herd Improvement Association. The average production of these herds climbed 897 pounds from the previous year to 15,943 pounds of milk per cow. This is the largest increase ever obtained in the state. DHIA cows in South Carolina fared well when compared to 13 other states processed at the Dairy Records Processing Center at Raleigh, N.C. South Carolina Guernseys ranked number one, outproducing Guernseys in all states of the region. South Carolina Holsteins advanced from fifth in 1987 to second place in 1988. South Carolina Jerseys were fourth in the 14-state region.



Clemson Extension dairy specialists put much emphasis on writing publications. Fifteen new ones dealing with different aspects of dairy production were produced in the past year.

### **Farm Economy**

In 1989 a new program was initiated with small-scale producers. More than 100 producers in 15 counties began using a simplified record-keeping system. This basic system was developed by the Clemson University Extension Service with minimum financial data being kept by participating producers. Each producer had to attend at least one county educational meeting on record keeping, filing and related subjects. Agents are making periodic follow-up visits with these farmers. In the future, participating producers will be given the chance to study other areas such as advanced financial analysis and production records.

Two days of intensified, high-priority training were presented to the Clemson University Management Assistance Program (CUMAP) personnel to address the borrower delinquency program initiated by the Farmers Home Administration. There was a major time crisis involved as the participating producers had only 60 days to respond to FmHA notices. CUMAP agents helped about 250 farmers prepare the necessary financial information. This help ranged from informal discussion to developing detailed financial data, including cashflow projections, financial statement information and income statements. About 1,500 hours of Extension staff time was committed to this emergency effort. Because of the time requirement, many hundreds of hours were devoted to this effort by Extension personnel during leave time as well as during the Thanksgiving and Christmas holidays. Some Clemson Extension agents are still working with these farmers to help them solve their financial problems.

CUMAP agents are also working with other farmers and farm families to evaluate financial and other farm alternatives. The priority placed on financial management training for agents in previous years made it possible to respond to this crisis situation in a timely fashion.

Two days of financial management training have been presented for Clemson Extension agents not working directly with CUMAP, and a one-day update was presented for CUMAP agents.

Publications now being distributed are a *Financial Management Newsletter* and a *Financial Management Notebook*, which accompanies videotapes. The Clemson *Financial Management Handbook* and the farm record books are now being revised. A small-farm record book is being prepared.

The following computer programs are now available:

- FINLRB (Long-Range Financial Planning)
- MONEY MAD (Short-Term Financial Planning)
- CASHMASTER (Record-Keeping Program)
- BUDGETS (Row Crop, Forage, Vegetable)

Seven financial management VHS tapes have been prepared, and efforts to put together a farm financial group paid off when the Sumter Farm Management Association was organized. This group is now in operation.



Financial management workshops were held this year in Clarendon, Lexington, Sumter and York counties, and financial management topics were incorporated into most production agriculture meetings.

Management newsletters have been started in Clarendon and York counties, and a series of news articles dealing with farm financial management have begun in many counties. In addition, a display committee is working on a small farm display targeted to management.

### **Forest Management Systems**

Clemson University Extension foresters coordinated a sale area layout and harvesting institute for U.S. Forest Service foresters and engineers for the sixth year. The training has involved 190 attendees from every National Forest in the eastern United States and has generated \$440,000.

A two-week silviculture workshop has been offered to Forest Service silviculturists for the past nine years and has been coordinated by Clemson Extension Forestry for the last four years. More than 100 students have attended the course. Another two-week short course was developed for Forest Service wildlife and fisheries biologists and silviculturists. This effort is part of a national project, with courses at Clemson for those states east of the Mississippi and courses at Oregon State University for western states.

Training materials were developed, and a series of best management practices training meetings has been initiated to train loggers and foresters on the effects of harvesting and road building on streams, water quality and soils. A statewide organization was formed to handle the arrangements for the 14 planned meetings across the state and to raise the \$12,000 of financial support. Eight meetings have been held to date with about 475 attending.

In conjunction with the Clemson Extension Forestry effort to promote the proper use of wood, four training meetings were held on the characteristics of wood as a building material, specification and installation of wood products, and avoiding problems with wood products in use. The meetings were for builders, architects, building inspectors, mortgage lenders, as well as Clemson Extension agents. About 150 attended.

Along the same line a \$20,000 grant was secured through the Extension Integrated Pest Management committee to develop videotapes on how to avoid moisture-related wood decay and insect problems in houses. Five videos are under development in cooperation with faculty in Forestry, Home Economics, Building Science, Entomology and Agricultural Engineering.

A two-day Pine Regeneration and Forestry Herbicides Workshop was conducted to train more than 100 professional foresters involved with pine regeneration under the Conservation Reserve Program. Based on current prices, lands in this program will generate more than \$250 million in gross revenue. Assuming that training will increase productivity by at least 2 percent, the workshop could potentially generate \$5 million dollars by the end of a 30-year rotation.

### **Home Food Production**

This year nine agents were trained in marketing of produce grown in home gardens. Ten agents were trained in more effective production of meat animals for home



consumption. An additional 25 agents were trained in the latest technology for producing fruit and vegetables at home.

Four agents were provided with resources to establish a mini-demonstration garden in a community. With the help of local volunteers, these agents were able to give demonstrations of proven techniques that could be easily extended to home gardens.

Several new leaflets on home vegetable production were developed and printed to be used by agents in promoting good management practices for home vegetable production.

### **Home Grounds**

Major efforts were initiated by the home grounds program team to train more Master Gardeners to help home owners with horticulture requests.

During 1988-89, 15 South Carolina counties conducted Master Gardener training programs. A total of 238 people were trained in county programs, with each Master Gardener returning a minimum of 30 hours of volunteer time to the Clemson Extension Service. In 1988-1989 Master Gardener volunteers gave 5,000 hours, valued at \$40,000, to Clemson Extension Service. Master Gardener volunteers now handle about 15 percent of the requests for home horticulture information.

Two advanced Master Gardener training sessions were held during 1988-1989, with 140 certified Master Gardener volunteers attending.

To help them make accurate diagnosis of plant problems, 25 Clemson Extension agents received two days of training in pest identification in shrubs and trees.

### **Horticultural Crops**

Extension activities in horticulture can be categorized into three groups: service to farmers/producers/consumers; support of local Clemson Extension professionals; and providing publications, videos and other written or taped material for all audiences. The past year saw a record number of grower education sessions sponsored by Horticulture. Educational programs were conducted by Clemson Extension horticulture specialists in conjunction with the S.C. Nurserymen's Association, the S.C. Landscape and Turfgrass Association, the S.C. Greenhouse Growers Association, and members of the golf course and sod-producing industries.

The National Peach Council held its national meeting in South Carolina this year, and the Clemson fruit crops specialist helped organize the program. A new Kiwifruit Growers Association has been formed, and an educational program for that group was organized by the small-fruits specialist.

The first annual meeting of S.C. Master Gardeners was held in conjunction with the annual meeting of the state Horticulture Society. Additionally, an advanced training session for Master Gardeners was held at Clemson in June with excellent attendance. Agent in-service training sessions were conducted in the areas of home grounds problem identification, commercial vegetable production, commercial turfgrass production and small-fruit production. A major emphasis is being placed on computer applications in horticulture. An in-depth session on computer-assisted landscape design was held recently in the department.



A computer demonstration was held at the annual meeting of the S.C. Nurserymen's Association, and Clemson Extension agents were provided in-service training on several aspects of computers, including desktop publishing.

The Horticulture Department cooperated with the Agricultural Communications group in buying, setting up and operating an interactive video kiosk in the Clemson Ag. Sales Center. This prototype unit is being used to provide timely information about all aspects of Extension programs and is used to study response to the CU Extension videodisk.

In addition to the range of newsletters and other Extension publications, a new type of material has been created and printed this year. The home grounds fact sheets and the home garden leaflets are designed to provide species-by-species information about the landscape features or production information, respectively.

Horticulture specialists are gaining international visibility and obtaining valuable experience and training in international horticulture. Two specialists accompanied S.C. growers on a trip to Chile, our tree fruits specialist visited fruit-producing areas of Egypt; our fruit postharvest specialist presented a paper at a meeting in Mexico; one individual made a trip to the fruit areas of Italy; and one of our vegetable specialists made two visits to China. Their experiences will be valuable in helping S.C. farmers enter the international market place.

### **Land and Water Resources**

Thrust 180, which provided training for county agents on the provisions of the 1985 Farm Bill, has continued to update Clemson Extension agents on the requirements. All counties have conducted training or provided this information to about 10,000 farmers or land owners. Farmers affected are in the process of carrying the provisions of the Farm Bill.

Thrust 181 provided training to 10 Clemson Extension agents on problems associated with high pH alkaline water and using wastewater for irrigation purposes. Testing equipment was provided to the agents so they could advise farmers of potential problems and best management methods.

Two thousand leaflets have been distributed on backflow anti-syphon devices and the state regulation that requires use of such devices on irrigation systems that inject chemicals on crops.

Three proposals were submitted and approved by the USDA Cooperative Extension System as part of the special appropriated fund to support water quality programs in FY 1989. These projects are groundwater pesticide applicator training, food and drinking water safety and waste disposal implications for water.

### **Livestock Management Systems**

Cash receipts from commodities are reported about one year late due to data collection. In 1987 income from cattle and calves ranked second in the state at \$116,069,000.



### S.C. Cash Receipts from Commodities

Commodity	1985	1986 (Thousand)	1987
Tobacco	167,498	111,955	149,140
Cattle & Calves	78,873	93,369	116,069
Dairy Products	90,530	85,465	83,967
Soybeans	129,922	85,840	82,568
Broilers	65,377	80,006	72,134
Eggs	67,246	74,155	69,507
Hogs	57,604	58,099	68,972

Income from hogs ranked seventh, and combined income from cattle and hogs would easily take first place with \$185,041,000. During the years shown, income totals from the red meat commodities are the only ones showing an increase each year, with cattle being the most substantial.

Certainly, drought conditions have forced extra animals through the markets, and this has some impact on income. However, there are educational programs and events that have influenced the quality of the product produced. Yearly field days at Clemson University animal science farm and at the Pee Dee and Edisto Research and Education Centers have had an impact.

Also, cow-calf clinics and mini-conferences at Anderson, Chester, Darlington and Walterboro have influenced the adoption of better breeding, nutrition and marketing programs.

South Carolina now has a monthly publication that reaches thousands of cattlemen, *The Carolina Cattle Connection*. It is published by the Cattlemen's Association and contains livestock news plus educational materials supplied by Clemson Extension, teaching and research professionals.

The Junior Beef Round-Up for young people continues to grow. In 1988, 150 youth with 220 heifers took part in this yearly event. In addition about 60 adults helped with hauling and organizing the show and the stockman's contest. This family affair, only in its second year, is extremely popular and appears certain to grow in the coming years.

### Marketing, Packaging and Utilization

Extensive efforts have been devoted to improving the quality and productivity of S.C. food processors. Quality and productivity are of critical importance if S.C. food companies are to be competitive in state, regional and national market places. Losses incurred by S.C. food processors are estimated to exceed \$300 million per year due to poor quality and low productivity. In response to this critical issue, Clemson Food Science personnel have developed a program to assist food processors in the implementation of quality improvement and statistical process control (SPC) programs. Training was provided to more than 200 individuals during 1988-89. In response, *Food Processing Magazine* (a trade journal for food processors) published an article on this project. It is estimated that more than 70 percent of the food processing managers in South Carolina read the article.



In 1988-89 the Defense Personnel Support Center of the Department of Defense required that all combat rations contractors implement an SPC program. Food Science personnel helped develop and implement an SPC for a major contractor in this state. This program was one of the first three to be approved, thus allowing the company to bid for contracts during the 1989 fiscal year. This guaranteed employment for 400 South Carolina workers. Ten managers were trained in SPC techniques. They in turn trained an additional 30 employees. During the first four months using SPC techniques, one quality improvement team was able to cut its use of electricity 10 percent.

The development of new food products is important if the size of the S.C. food processing industry is to increase. Clemson Extension Food Science personnel co-sponsored a symposium of flavors. More than 86 quality control and research development scientists were trained in the application of flavor methodology to new food products.

Food scientists were instrumental in helping a major South Carolina food processing company secure one of its ingredients from an in-state source rather than from an out-of-state company. This should increase the sale of the South Carolina ingredient by at least \$.5 million per year.

Processed crab is South Carolina's second largest seafood industry, but market demand for fresh, pasteurized and canned crab meat exceeds South Carolina's catch. Most South Carolina crab meat processors require outside sources for the additional meat needed to process the volume they sell.

To help S.C. companies secure a supply of crab meat, a unique procedure to semi-process raw crab meat in five-pound chubs suitable for frozen storage was developed. This procedure has resulted in a new source of semi-processed crab meat, which is expected to net retail sales from S.C.-manufactured crab meat products by more than \$500,000 in 1989.

This will also extend by about 30 percent the number of off-season days per year employees will be needed to work in the state's processed crab meat industry.

### **Poultry Management Systems**

The major emphasis has been on improving the quality and efficiency of all types of poultry housing in South Carolina. Poultry housing represents 55 percent of the total capital expenditure in all vertically integrated poultry operations.

South Carolina is experiencing constant expansion, which has resulted in the construction of many new facilities. Information has been provided to assist poultry companies with the development of new housing in a variety of ways. The third S.C. Poultry Housing and Ventilation seminar attracted 65 company representatives interested in learning about methods to automate poultry housing and incorporate computers to control house environment.

A monthly column in a trade publication has been developed to provide companies with a resource for new technology related to housing, ventilation and management. Educational programs on hot weather ventilation were presented at regional and international meetings.

Additionally, housing and ventilation recommendations were developed for three commercial companies. A program under development in cooperation with the Depart-



ment of Agricultural Engineering will monitor and evaluate the economic efficiency of the broiler house design developed for the S.C. industry.

Concern over the bacteriological quality of poultry products has resulted in a number of educational programs. At the request of the commercial egg industry, a document was developed to provide a statewide program for monitoring and reducing the incidence of *Salmonella enteritidis* in commercial layers. This has helped commercial producers implement a voluntary monitoring program to help ensure the bacteriological quality of all S.C. egg products. Additionally, the S.C. Poultry Health Advisory Board was established to advise the poultry industry on matters related to poultry health and the impact on human health.

### **Agricultural Engineering**

This past year five Agricultural Engineering projects were initiated on energy conservation for agriculture. These projects were farm tractor efficiency tests, greenhouse energy audits, whole farm energy audits, irrigation pump efficiency tests and vegetable cooling methods.

Early results include the following: some new greenhouses tested have air inlet openings only 50 percent as large as are actually needed; a high pressure pump had been installed in a drip-trickle irrigation system. Since a drip-trickle irrigation system is a low-pressure system, a pressure reducer had to be installed after the pump discharge, making for a very inefficient system.

Two instrumented grain storage facilities were operated this past year, one at the Edisto Research and Education Center and another at the Pee Dee Research and Education Center.

They provided continuous data on temperature and humidity of the stored grain. When grain conditions develop that could result in insect or moisture damage, advisories would be issued through Clemson Extension offices in the counties and through local radio stations.

Aerial applicator fly-ins were conducted in the state to educate pilots on proper calibration procedures for applying pesticides. Sprayer calibration kits were distributed to the districts. These will be available for Clemson Extension agents. Thirteen county/state programs in sprayer calibration were conducted this year.

The Get Fired Up 4-H fire safety program for grades 4, 5 and 6 continued. The program is coordinated with the various schools' local fire departments in towns such as Anderson, Easley and Florence. Students in more than 30 counties participated in the annual 4-H fire safety contest.

As a follow-up to this program, several newspaper articles carried a story about a youngster who reacted as he has been taught in the Get Fired Up program and put out a fire at his home.

Agricultural weather advisories were provided several times a week during the growing season from the Clemson University Agricultural Weather Office. The information is made available to the public through the National Weather Service and through personal interviews with newspaper writers.

A radon slide set was developed to explain the hazards and control measures for this gas in residences. Presentations were made in each district in the state. Copies of the slide set and text are available in each Clemson Extension office.



The Clemson University Housing Institute, a multi-discipline unit, made available grants of about \$2,000 each to several Clemson Extension offices in the counties to carry out demonstration and education programs. These programs ranged from building displays for home shows to providing travel to meetings.

### **Entomology**

In conjunction with the Department of Fertilizer and Pesticide Control, Entomology began recertification of pesticide applicators in 1989. This program provides for mandated continuing education for certified applicators. As of June 30, 1989, more than 3,000 have been trained.

One of the more successful efforts has been our Hessian fly program for wheat. This fly is a major yield-limiting factor in Southeastern wheat production. On-farm demonstrations in 10 counties and at the Clemson University Edisto Research and Education Center showed how to manage this pest using integrated control. Yield increases of 30 bushels per acre have been demonstrated. As a result of this work, the life cycle of the Hessian fly in the Southeast is now understood, and practical control is possible.

Extension Entomology is actively involved in programs supporting major crops, including tobacco, cotton, soybeans and peanuts. The boll weevil eradication program is an example of a program that is a continuing success. This program has made cotton a competitive crop once again. Reduced losses caused by insects and lower pest control costs are major factors in the resurgence of cotton as a profitable agricultural enterprise.

Extension Entomology supports urban programs, particularly educational programs for home owners plagued by problems with insects, wood decay and moisture. A major thrust is under way to remedy many of these problems by educating the housing industry and developing practical solutions.

### **Horticulture**

Horticulture sponsored a record number of grower education sessions this past year. Educational programs were conducted by Clemson Extension specialists in conjunction with the S.C. Nurserymen's Association, the S.C. Landscape and Turfgrass Association, the S.C. Greenhouse Growers Association, and members of the golf course and sod producing industries.

The National Peach Council held its national meeting in South Carolina this year, and Horticulture's fruit specialist helped organize their program. A new Kiwifruit Growers Association has been formed, and an educational program for that group was organized by the small-fruits specialist.

The first meeting of South Carolina's Master Gardeners was held in conjunction with the annual meeting of the state Horticulture Society. Additionally, an advanced training session for Master Gardeners held on the Clemson University campus in the summer drew excellent attendance.

Horticulture is putting major emphasis on computer applications in horticulture. Using the department's Macintosh computer laboratory, horticulturists held an in-depth session on computer-assisted landscape design. An extensive computer applications demonstration was held at the annual meeting of the S.C. Nurserymen's Association short course.



The Horticulture Department cooperated with Clemson Agricultural Communications personnel in buying, setting up and operating an interactive video kiosk in the Ag. Sales Center. This prototype unit is being used to provide timely information about all aspects of Extension programs and is used to study response to the CU Extension Videodisk.

In addition to the range of newsletters and other Extension publications, a new type of material has been created and printed this year. The *Home Grounds Fact Sheets* and the *Home Garden Leaflets* are designed to provide species-by-species information about landscape features or production information, respectively, rather than attempt to answer all questions about all the different plant types.

### **Plant Pathology and Physiology**

From thousand-acre farmers, to golf course managers, to truck crop growers and home gardeners, the Plant Problem Clinic continues to increase and upgrade its services to the state.

Prompt, accurate diagnoses have saved commercial producers and homeowners millions of dollars by showing them how to reduce pesticide applications, use more effective pesticides, or use the correct treatment the first time.

With help from the nematology section of the Ag. Services Laboratory at Clemson University, surveys for soybean cyst nematodes and nematodes associated with peanuts were conducted. The impact is that plant breeders now know the nematodes for which they should develop host plant resistance.

The Plant Pathology Department began a small initiative on commercial turfgrass problems this past year. Results have demonstrated that much can be gained by accurate diagnoses and education programs.

## **Strengthening the Family**

### **Family Life Education**

Parenting was selected as the major program area in family life education. In-service training was conducted for agents. Materials were developed for parents of children 5-12 years of age, and the program developed last year for parents of children up to four years of age was managed. In addition to conducting the parenting programs themselves, the agents trained volunteers and people from other agencies. More than 5,000 parents claimed to have improved parenting skills as a result of these programs. More than 4,000 parents reported that they had increased their knowledge of child development.

The Children and Adult Resource Express (CARE), an information and referral system for dependent children under 17 and dependent adults over 55, was maintained, updated and improved. The information in the CARE database is free to South Carolinians and can be accessed through their local Clemson Extension Service office. Use of this database continues to grow.

### **Family Resource Management**

During 1988-89 the family resource management team has developed and supported statewide programs designed to help individuals and families improve their financial stability by gaining and maintaining control of finances and other resources throughout their lifetime.



Thirty-seven counties have planned and conducted File It, Find It programs reaching more than 1,500 participants. About 25 percent of those participating organized a home filing system. One participant said, "In addition to a marriage license and premarital counseling, File It, Find It should be a prerequisite to marriage." Participants estimated that by being better organized, they could save an average of 10 hours a month. They placed a dollar value on the time saved between \$5 and \$100. An additional 4,300 South Carolinians attended programs designed to help them use resources to ensure financial security. Of those participating in goal-setting programs, 85 percent set financial goals for themselves for the coming year.

About 1,800 young people took part in career exploration programs, and 200 gained skills in financial planning and organizing. Special emphasis was placed on encouraging couple participation in financial management programs to improve family financial planning. Couple participation in financial management Extension programming during 1988-89 increased 122 percent over the previous year.

## **Housing**

Damage to residential housing from excessive moisture exceeds the costs of termite damage. This problem is particularly severe in South Carolina because of our coastal location, climate and topography.

Identification, prevention and correction of home moisture damage is a major educational thrust of the Clemson Extension Service housing program in the years 1987-91. In 1988-89, 57 Extension professionals have reported the following accomplishments in 17 counties: (1) \$140,515 saved by prevention and/or corrective actions; (2) 276 existing homes altered to correct or prevent moisture damage; (3) 266 new homes designed or built to avoid moisture problems; (4) 634 industry officials trained to prevent or control moisture damage; (5) 56 lay leaders trained to teach control and prevention; and (6) more than 4,700 people received information on how to prevent or correct moisture problems in their homes. One Extension agent helped the Council on Aging get a grant to correct moisture problems to a city seniors' center.

A three-part benchmark data project funded by the Fulbright Commission and several organizations in South Carolina and Scotland is designed to document what percentage of South Carolina homes have moisture problems and the cause of these problems.

Data indicate that 50 percent of the sample houses in part I of the study had moisture damage. Further data from more than 1,600 homeowners and pest control operators are being studied.

The Clemson University Housing Industry Advisory Council was formed in 1988 to provide industry leader insight for Extension housing programs. CUHIAC members represent realtors, architects, utility companies, lenders, building inspectors, building material suppliers, and Clemson Building Science faculty.

South Carolinians may use the 250 housing information resources (audio cassettes, videotapes, slide programs and printed materials) listed in the computerized Home Economics resource directory accessible in their local Clemson Extension Service office.

In 22 counties Extension professionals helped people solve other housing problems, including: 22 families who adapted existing homes for use by elderly or handicapped



family members; 17 families who remodeled their kitchen, bath or entire home; 60 families planned new homes; 4 households considered alternative housing; and 49 families improved home storage. Twenty-three volunteers were trained and taught housing lessons to 197 lay people, and 186 citizens took part in housing study tours.

## **Developing Human Resources**

### **Health and Wellness**

More than 30,000 youth participated in the 4-H fire safety education program that helped identify potential hazards in their home and community.

In-service education has prepared Clemson Extension Service agents and community emergency medical teams in first-on-the-scene farm accident rescue techniques. They will take this information to farm families and workers.

Local Teen Pregnancy Prevention Councils are functioning in 28 of the 46 counties. The program of each local council is based on needs identified in the county. Several councils have applied for tax-exempt status, making them more eligible for private funds.

Exemplary projects include Lancaster County's "A friend in your pocket," a business card-size listing of phone numbers given to all teens. The numbers will offer health information and services. The card recently proved its worth when a teen contemplating suicide used it to call one of the numbers. This person was talked through a difficult situation and directed to help.

The councils are under the auspices of the State Maternal, Infant and Child Health (MICH) Council out of the Governor's Office. The Clemson Extension Service provides major leadership in the State MICH Council and the majority of the Local Teen Pregnancy Prevention Councils.

The *Baby Talk* series has reached more than 3,000 families in the past year with a monthly newsletter. *Baby Talk* was recently introduced to all physicians delivering babies or providing health care for babies as a method of providing more health education to families with young children.

Currently ranked 49th in the nation in infant mortality, South Carolina continues to focus education programs on this problem. State reports have determined that a major portion of the problem is in six of the larger counties. Efforts are under way to get *Baby Talk* to many more families in these six counties.

The Stress, Health and Coping program is based on needs that were identified from the problem-identification process in South Carolina and through an in-depth agro-medicine study of families in Beaufort and Orangeburg counties.

Stress is considered to be a major health problem in the state. It is a contributing factor in coronary heart disease, migraine headaches, asthma, peptic ulcers, colon disease, mental disturbances, allergies, suicides and auto and farm-related accidents.

For these reasons the Clemson University Extension Service has initiated an effort to reduce stress. The first phase of this effort — the training of Clemson Extension personnel in the counties — was completed this year. Counties are now teaching stress reduction techniques to a variety of audiences, including youth.



## **Human Nutrition**

During the 1988-1989 program year, human nutrition programs continued to concentrate efforts in two major areas. The first emphasized helping consumers make wise food choices, while the second provided information on the safe handling of the food supply. Nearly 100,000 persons received Extension education programs and information in these two thrusts from July 1, 1988, through June 30, 1989.

More than 85,000 consumers were reached with educational efforts aimed at helping them make wise food choices. Programs emphasizing dietary guidelines, better eating for better health, reading food labels, food buying and meal planning were presented to about 37,500 consumers. Clemson Extension agents estimate more than 2,800 program participants have improved their eating habits. More than 37,000 consumers learned the relationships between nutrition and the chronic diseases. Nearly 125 participants in a Clemson Extension diet puzzle weight control program lost at least 12 pounds each during the series. About 2,500 people learned to evaluate nutrition information and claims that appear almost daily in the mass media, and about 6,000 developed new skills in food preparation.

The safe handling of food is a priority topic in Extension programming. Under this thrust, more than 5,000 persons received information from local Clemson Extension agents on safe food handling practices. A program on the conservation of food at home through safe food preservation methods was presented to about 4,700 clients.

## **Human Nutrition (EFNEP)**

EFNEP (The Expanded Food and Nutrition Education Program) is a federally funded program celebrating its 20th anniversary in South Carolina this year. Administered by the Clemson University Cooperative Extension Service, it developed out of the war on poverty of the late 1960s when it became apparent that malnutrition was a nationwide problem that crossed racial, ethnic and geographic boundaries.

Its primary purpose is to improve the diets of limited-resource families and youth, thereby enabling them to enjoy better health, improved stamina and increased productivity. More than 300,000 South Carolinians, about 15 percent of the state's population, have incomes below the poverty guidelines.

During 1988-89, 4,124 limited-resource homemakers were reached through EFNEP's adult phase in 40 counties. More than 50 percent of these homemakers graduated in 12 months or less by reaching a designated level of proficiency in relation to food and nutrition knowledge and practices. Ninety percent of enrolled homemakers showed improvement in their diet and food handling practices.

In 4-H EFNEP 5,638 youth were reached in 1988-89. They studied wise food choices and how to handle food safely. Most participated in community groups led by volunteer leaders. More than 630 leaders contributed more than 8,000 hours to the program. About half of the young people in the EFNEP program also participated in other 4-H activities or became involved in other 4-H groups and activities after graduating from youth EFNEP.

EFNEP homemakers were informed of services of other agencies, especially those related to health and nutrition. There has been a steady increase in the number of referrals to EFNEP from other agencies in the past three years.



Since 1969 EFNEP in South Carolina has initiated a computer record-keeping system, innovative program delivery methods (such as group teaching, newsletters and videotapes), and has instituted a statewide curriculum.

Over the past 20 years the program has reached more than 66,000 homemakers and 82,000 youth in 44 of the state's 46 counties. EFNEP has helped these people gain the knowledge, skills, attitudes and behavior changes necessary for securing nutritionally sound diets and to contribute to their personal development.

### Leadership

The leadership program team developed three objectives to be accomplished over the four-year plan of work:

- Develop a statewide leadership consortium.
- Develop a leadership training system.
- Develop a volunteer leadership management model.

Major efforts this past year continue to be in the second objective.

The overall plan for 1988-89 was for Clemson Extension agents and volunteers to attend two training sessions covering the Family Community Leadership materials. The first training covered the importance of volunteers, success stories, building interest, recruitment, involvement, retention, self-knowledge, communications, group formation, team building, leadership, teaching methods, holding effective meetings and working with groups.

The second program, scheduled this November, will cover group process, decision making, conflict, issue analysis, public policy, lobbying, and developing county plans. Plans call for repeating this cycle for a new group of agents and volunteers in 1990-91.

The first session trained 65 Clemson Extension staff and 85 volunteers from 41 counties.

Follow-up evaluation reports of time, activities and contacts from the volunteers were requested each six months. Based on the reports received by this date, projection indicates the following results for a six-month summary of time and contacts made by the 85 volunteers involved in the training.

Hours spent training others .....	765
Hours spent in preparation .....	2,550
Hours spent in public contact .....	2,125
Hours spent traveling .....	765
Miscellaneous hours .....	255
Total hours .....	6,460
Total people reached .....	5,765

The Clemson Extension Homemakers Council represents a major volunteer leadership effort. South Carolina's growing population increases the potential audiences needing Clemson home economics information. Cuts in appropriations and resulting reductions in county staff have emphasized the need for volunteer leadership development to continue and expand the impact of the Extension Homemakers organization and other Extension volunteers.



The S.C. Extension Homemakers Council has active councils in all counties, with more than 6,000 member volunteers. The value of Extension Homemakers volunteer time is estimated to be more than \$1,000,000 annually reaching thousands of clientele, multiplying the efforts of the Clemson Extension Service in disseminating educational information.

### **Youth Development**

Increasing numbers of young people are becoming separated from the mainstream of American life and are therefore often unprepared to play responsible and productive adult roles in society. The Clemson Extension Service has recognized this trend and is developing new programs in such areas as teen pregnancy, substance abuse, teen suicide, poverty, malnutrition, health and illiteracy.

Clemson Extension has been taking a lead role in exploring the many possibilities for interdepartment, intercollege and interinstitutional collaboration for addressing the current needs of South Carolina's young people. Partnerships are being established with other state agencies and other youth groups in the state. The life skills training in the basic needs of communications, decision making, leadership, group process and career exploration are giving young people the opportunity to develop their abilities to cope with a variety of life situations.

Training was provided and examples shared on the topic of involving youth in the community decision-making process. Peer teaching, community-wide youth roundtables and leadership skill development can be documented. 4-H opportunities provide youth with the experiences needed to gain coping skills, competency skills and contributory skills, all necessary for successful adulthood. Teen involvement in statewide program decision making is increasing. Knowledge transfer in the areas of business and management, careers and jobs, communication, decision making, leadership and group process, learning and knowledge transfer, relationships, and understanding and accepting oneself continue to be core curriculum areas for Youth Development programming.

4-H enrollment now includes more than 58,000 young people and 3,000 volunteers. Sixty three percent come from farms and rural areas, with 5.5 percent living on farms. Twenty-two percent live in cities with populations of 10-50,000. Forty-seven percent are black, and 52 percent are white.

## **Developing Communities**

### **Rural and Community Resources**

The Rural and Community Resources program team conducted an in-service training program for 25 Clemson Extension agents and specialists on "Public Awareness of Environmental Issues." Topics included litter control, organizing and conducting Keep America Beautiful and Take Pride in America community improvement programs.

The group toured the Ridgeway goldmining operation in Fairfield County to see how environmental impacts were being managed. In-service training planned for 1989-90 includes rural revitalization and economic growth and planning for community growth.

A pilot program entitled WORKS is being conducted through this team in cooperation with the family resource management program. It is funded primarily by the



American Association of Retired Persons to help midlife and older persons in occupational transition.

As a result of the initial success of the program in Orangeburg county in 1987-88, South Carolina has been chosen by AARP as one of five states to participate in its expansion to other parts of the nation. An in-service training program is planned for Extension agents and designated volunteers from counties included in the expansion.

Rural and Community Resource program team members are substantially involved in developing and implementing the Palmetto Leadership Program. This three-year rural community leadership program is a pilot project partially funded with a \$1.1 million grant from the W.K. Kellogg Foundation. Matching funds will come from Clemson University through in-kind services. One major objective of the project is to demonstrate the capability of the land-grant system to provide resources for leadership education at the county level through the coordinating efforts of local Extension offices. Four pilot counties were chosen based on selected criteria. Training sessions on a variety of leadership topics were conducted in each county primarily by university faculty. An average of 35 local leaders per county were trained in this initial phase. Plans are to expand the project into additional counties each year while continuing to assist previously trained leaders in their efforts to address problems identified and targeted locally. Team members are involved in many additional projects and activities that have as an objective the development of rural and community resources.

A member serves on the task force on working with diverse audiences created by the Extension Committee on Policy (ECOP) to determine how Extension may more effectively reach audiences not currently being served by its programs.

A member is being trained on use of IMPLAN (IMPact analysis for PLANning), an input output model and database system developed by the USDA Forest Service "...to allow communities to determine what effect industries have on each other."

Other activities of this program team include establishment of a videotape resource library; distribution of a resource notebook to all counties describing exemplary Extension programs from across the nation; and development of formal working relationships with the State Development Board to strengthen county economic development and leadership programs.

## **DIVISION OF REGULATORY AND PUBLIC SERVICE PROGRAMS**

The Division of Regulatory and Public Service Programs began in 1970 and consists of the director's office and four departments: Fertilizer and Pesticide Control, Plant Industry, Seed Certification and a portion of Agricultural Chemical Services.

The division's mission is to ensure compliance by regulated industries and individuals with legislative mandates and regulations. The division also provides its target audiences assistance and services to educate and achieve compliance.

Division programs promote the use of certified seeds and plants; provide the services needed for certification of crops and plants; assure that fertilizers, lime, pesticides



and seeds meet the standards to produce marketable, safe and profitable crops; provide inspections to monitor pesticide treatments by the pest control industry; and provide inspection to assist the state's plant industry in maintaining plant material and agricultural commodities apparently pest free.

The following activities, by department, highlight the divisions' work for 1988-89.

### **Agricultural Chemical Services**

This department performs the chemical analyses reported by the Department of Fertilizer and Pesticide Control. Most samples were multi-component, with more than 23,000 individual analyses made.

The laboratory has concentrated on improved methodology, instrumentation and organization to analyze all samples quickly and accurately. The department performed more than 41,000 analyses for the S.C. Agricultural Experiment Station during the fiscal year. In addition, the Agricultural Service Laboratory processed more than 78,000 soil samples, 5,000 plant and feed samples and 5,100 samples for nematodes.

### **Seed Certification**

Seed Certification is a program of standards imposed on the seed and plant production industries that ensures varietal purity, good germination and freedom from noxious weed seeds. Participation in the program is voluntary.

The General Assembly designated Clemson in 1945 as the agency to inaugurate and carry out a program of certification of pure seed and plants in South Carolina.

Departmental field work in 1988-89 involved inspections of 33,346 acres of crops for certified seed production. Inspections included 83 varieties of 15 crops for 185 farmer/growers and 17 seed-producing firms. Inspectors checked each field to determine that the crop was true to variety and free of noxious weeds and seed-borne diseases.

Acreages of major crops inspected were soybeans, 17,775; small grains, 11,013; cotton, 2,789; peanuts, 1,082; turfgrasses, 285 and pine trees, 330. Other field work involved grow-out plantings of 230 samples of South Carolina certified soybean and small grains seed for comparison to the producers' or seed conditioners' samples of the same lots.

During 1988-89 the department issued 669,855 certified seed tags to growers whose seed met standards in the field and laboratory. Inspectors checked and approved 27 facilities during the year for custom conditioning of South Carolina certified seed.

### **Fertilizer and Pesticide Control**

The Department of Fertilizer and Pesticide Control is responsible for education and enforcement of the provisions of a number of laws and regulations. The South Carolina Fertilizer Law and the Liming Materials Act are designed primarily to ensure that consumers receive high quality fertilizer and lime, while the Pesticide Act regulates pesticide storage, sale, use and numerous other practices such as quality control and structural pest control.



Some of the major activities of this department relative to fertilizer and lime from July 1, 1988, to June 30, 1989 follow:

Fertilizer tons sold .....	476,850
Fertilizer samples procured & analyzed .....	3,924
Fertilizer samples not meeting guarantee .....	930
Lime material & samples procured & analyzed .....	301
Total number of liming material samples not meeting guarantee .....	11
Percent of liming material samples deficient .....	3.7
Fertilizer penalties collected, payable to State Treasurer** (Deficiencies where consumers not identifiable) .....	36,120.00
Lime penalties collected, payable to State Treasurer** (Deficiencies where consumers not identifiable). ....	963.00
Fertilizer registration fees collected, payable to State Treasurer** .....	29,230.00
Lime registration fees collected, payable to State Treasurer** .....	1,000.00
Lime permit fees collected, payable to State Treasurer** .....	2,980.00
Fertilizer taxes turned over to State Treasurer** .....	171,760.00

\*\* Actually recorded by State Treasurer July 1, 1988-June 30, 1989,  
but may not correspond to final fees paid for the fiscal year.

The fertilizer tonnage sold this year increased slightly from 1987-88. Overall 24.0 percent of fertilizer samples did not meet the guarantees within the investigational allowances. This deficiency rate rose from 1987-88. Other than deficiencies, the greatest problem in the fertilizer and lime areas continued to be the lack of proper labeling of bulk material.

The South Carolina Pesticide Control Act mandates quality control monitoring and regulates the sale, use and application of all pesticides used in South Carolina. The department uses a strong preventive education program coupled with fair enforcement actions when necessary to help ensure productivity while preventing adverse effects on man or the environment.

In an effort to improve its education and enforcement capabilities, this department has pursued external funding without decreasing the flexibility of the pesticide program. These efforts have resulted in a \$324,900 grant from EPA. The department also has made a concerted effort to increase efficiency by using state-of-the-art data management. All fees collected under this act are sent to the state treasurer.

In 1988, 779 companies registered 7,683 pesticide products for sale in South Carolina. The department collected and analyzed 836 pesticide samples. Inspectors found three deficient in the guaranteed percentage of one or more ingredients and issued stop-sale notices. The department collected \$132,716 in registration fees.



Using provisions of the Federal Pesticide Control Act, the department issued three Section 24 (C) special local need registrations. The EPA granted the only Section 18 emergency exemption solicited by the department.

Pesticide dealers and applicators must be certified and licensed to buy, sell or apply pesticides classified for restricted use. Last year 9,931 private applicators licenses, 1,829 commercial applicators licenses, 794 noncommercial licenses and 351 pesticide dealers licenses were issued. The department collected \$61,948 in certification fees.

In the area of education and enforcement, the department's specialists made frequent contact with pesticide users, including dealers, growers, applicators and consumers. The structural pest control area requires particular attention. The Pesticide Act was amended to strengthen regulatory efforts. Dealer inspections and meetings with pest control operators assisted this transition. The department is drafting regulations mandated by the Chemigation Act.

Enforcement actions against violators were decisive but fair. As part of the EPA/DFPC Cooperative Enforcement Grant, the department made 330 marketplace inspections, 199 certified applicator record checks and 211 restricted use pesticide dealer inspections.

The department levied 38 civil penalties ranging from \$50 to \$850 and totaling \$9,900. Two criminal prosecutions resulted in convictions. Investigators pursued 377 cases of potential pesticide misuse or noncompliance with regulations. They issued numerous stop-sale notices for unregistered products, sale of restricted products by unlicensed dealers and other alleged violations. The department issued warning letters in 96 cases. Overall compliance with the act by members of the agribusiness industry has been excellent.

The department's regulatory programs sent \$446,617 to the state treasurer.

## **Plant Industry**

Activities within the department for 1988-89 fall into 13 subject areas, reported as follows:

*Nursery Inspections:* Under provisions of the Crop Pest Act, the department licensed 593 nurseries, greenhouses and vegetable transplant growers and 1,026 nursery dealers, including nine dealers outside the state, to sell plant material. Inspectors visited another 226 establishments to determine compliance with quarantines and regulations concerning pest problems. Forty-two other nurseries failed initial inspections due to pests, weeds or other problems.

*Phytosanitary Certification:* The department issued approximately 195 phytosanitary certificates (180 state and 12 federal) for plant material. The plant material consisted mainly of orchids, chrysanthemums and propagative native plants destined to other states, Canada, Puerto Rico and 23 foreign countries. About 80 percent of the plant material was shipped to Hawaii, Puerto Rico, Canada and California.

*Miscellaneous Inspections:* The department issued 17 regular certificates of plant inspection for assorted houseplants being moved to six states. Florida accounted for more than 50 percent of the certificates. Inspectors also cleared plants for shipment to Arizona, California, North Carolina, Texas and Vermont. Six Pee Dee tobacco growers



received plant bed inspections, which led to the sale of about 1.6 million transplants to North Carolina growers.

*Post-Entry Inspections:* The department conducted eight post-entry inspections, mainly roses from England and feijoa plants from New Zealand, for individuals in seven S.C. counties.

*Phony Peach:* Inspectors, including four temporaries, handled the 1988 survey for phony peach disease in the Ridge, Sandhill and Coastal Plains areas. Out of 1.2 million trees surveyed, 343 (0.03 percent) diseased trees were destroyed.

*Sweet Potato Inspections:* About 20 growers in the Pee Dee, Sandhill and Coastal Plains regions received 26 inspections.

*Bee Disease Act:* The Varroa mite, first found in the state last year, appeared again in three South Carolina counties (Pickens, Greenville and Laurens) during 1989. Migratory beekeepers accounted for all the finds. A statewide Varroa mite survey of migratory, resident commercial and hobby beekeepers continued this year. The department surveyed 230 apiaries with 5,485 colonies of bees in 27 counties. Inspectors sampled 13 percent of these colonies for the Varroa mite using the Apistan strip method. During other bee inspections, the department confirmed tracheal mites in 21 apiaries, nosema disease in three colonies and American foulbrood in three colonies. USDA inspectors captured the state's first Africanized Honeybee swarm from a vessel at the Port of Charleston on April 27, 1989.

*Neglected and Abandoned Orchards Act:* Neglected and abandoned peach orchards in Spartanburg County cause insect and disease problems for other commercial growers. Consecutive freeze-outs and hail storms contributed to the demise of large farms and many smaller orchards. The problem began when this acreage was subdivided into residential lots and sold without the peach trees being removed. The department ordered about 50 property owners in accordance with the statute to properly maintain or destroy the trees because of the potential for harboring and spreading insects and diseases. Owners cooperated, destroying neglected peach trees on about 1,300 acres.

*Cooperative State/Federal Programs:* The department and USDA renewed a cooperative agreement in 1988 which provides for seasonal employees. The program created temporary jobs for about 60 people to perform survey and control activities associated with the witchweed and gypsy moth efforts.

*Witchweed:* Statistics for 1988 show that only 15,188 acres remain infested in South Carolina. In 1988 inspectors found 475 new infested acres and released 2,779 acres from quarantine. A total of 64,952 acres have been released since the beginning of the program. A total of 11,200 acres were treated under contract.

*Gypsy Moth:* In 1988, the department trapped only 123 adult male moths, compared with 642 in 1987. Most (97) were in Horry County. More than a third of those (39) were at Surfside, where a small, local infestation existed. The tremendous count reduction was attributed to three ground applications of *Bacillus thuringiensis*. About six acres were treated during early larval development.

*Boll Weevil:* No major problems marred the 1988 program. Grower fee collections amounted to about \$1.2 million. The General Assembly appropriated \$100,000 to be refunded to cotton producers to offset a portion of their fees. This refund amounted to 69 cents per acre. Boll weevils are practically non-existent in the old eradication area.



In 1989 only 25 weevils have been trapped in seven fields. The buffer zone still accounts for weevils this year, but in much lower numbers than the same period last year.

*Imported Fire Ant:* This pest continues to spread throughout the state. The majority of the department's efforts involved working with nurseries, turf growers and other individuals to certify plant material for shipment to other states. Department personnel supervised specific regulatory treatments for this purpose.

## **LIVESTOCK-POULTRY HEALTH DIVISION**

The Livestock-Poultry Health Division conducts a number of regulatory programs in consumer protection, animal health and the diagnosis of various diseases in S.C. livestock. The division's three main responsibilities are the administration of the S.C. Meat and Poultry Inspection Programs, the Livestock Health Programs and the Diagnostic Laboratory.

### **Meat and Poultry Inspection**

The S.C. Meat-Poultry Inspection Department serves as a public health regulatory agency within the guidelines of state and federal laws to assure that meat and poultry products inspected by the department are safe, wholesome and accurately labeled.

In cooperation with USDA and FDA, the department began major initiatives to test for drug and pesticide residues in meat products. Identified problem areas will receive follow-up investigations.

The USDA provides up to 50 percent funding for the state inspection program if the USDA determines the state program is "at least equal to" the federal meat inspection program. The S.C. program was found to be equivalent to the federal program.

Approximately 112 meat and poultry plants are inspected for plant sanitation and product quality. An active compliance program is in place to ensure that the department will continue to provide effective and efficient inspection services.

### **Animal Diagnostic Laboratory**

The veterinarians and laboratory technicians serve a broad range of citizens. The staff provides assistance and service to veterinary practitioners and animal owners throughout the state for livestock, poultry and companion animals.

The most frequent service provided owners of companion animals is a blood test for equine infectious anemia. Many states, including South Carolina, require a negative test before interstate transportation of horses, and most shows require a negative test before arrival. During the past year the laboratory conducted 9,662 tests for equine infectious anemia.

A total of 3,951 tests were performed for pseudorabies in swine and 167,965 tests for brucellosis in cattle.



The laboratory serves a dynamic poultry industry that is a top producer of agricultural income in the state. The areas of major concern are disease diagnosis, management practices, vaccination programs, and monitoring flocks for vaccine response and disease outbreaks. In addition to broiler chickens, turkeys and table eggs, S.C. produces many bobwhite quail for processing and pigeons for squabs.

The veterinary profession and veterinary laboratories serve the citizens by assisting the animal industry to provide high quality, safe and economical food to the nation. Similar services for companion animals contribute to the health and happiness of our people.

### **Livestock Health Programs**

In 1901 the General Assembly authorized the trustees of Clemson College to employ a veterinarian for livestock disease investigation purposes. From this humble beginning grew total concepts to control and eradicate those livestock diseases that cause great economic loss to commodity groups and pose potential public health problems.

A Swine Pseudorabies Monitoring Program and Swine Brucellosis Survey began January 1, 1989. During the ensuing six months, 380 swine herds were tested under this program. Because of problems in other parts of the country, the department plans to identify and eliminate salmonella contamination in livestock, poultry and meat and animal byproducts. All livestock going through auction markets are inspected for evidence of contagious and infectious diseases.

Regulatory personnel attended 1,227 sales and inspected 350,630 animals. In addition to the various activities carried out by full-time employees, the division contracts with practicing veterinarians to attend each public sale of livestock to perform the necessary tests, vaccinations and other tasks to ensure that all animals meet intrastate and interstate requirements for sale and movement.

## **COLLEGE OF FOREST AND RECREATION RESOURCES**

The College of Forest and Recreation Resources will continue to meet the needs of South Carolina through aggressive education, research and extension programs aimed at managing the state's assets and enhancing the quality of life for S.C. citizens through the wise use of leisure and the creation of pleasing living environments. The importance of this college's function comes under sharp focus when it is noted that the college is the center of expertise for two major industrial groups in South Carolina. Together the forest and recreation tourism industries contribute approximately \$8 billion annually to the state's economy.

All research and extension activities in forest management, wood utilization, and recreation resources and services are the responsibility of two departments—the Department of Forestry and the Department of Parks, Recreation and Tourism Management. Both departments offer educational programs from the baccalaureate to the Ph.D. In addition the Regional Resources Development Institute, created in 1981, operates



under the auspices of the college and examines issues in natural resources allocation and community development throughout the state and region.

Founded in 1970, the College of Forest and Recreation Resources is responsible for promoting the wise management, use and stewardship of the natural resources of the state, region and nation. One of the premier activities at the University is carried on in the PRTM Outdoor Laboratory. Programs at the Outdoor Laboratory provide camping and other outdoor experiences for physically handicapped children, emotionally disturbed citizens, blind and hearing impaired children, and hemophiliacs. The primary support for this effort comes from the interested civic clubs and citizen groups throughout South Carolina, and the program provides unusual laboratory experience for many Clemson students.

## Forestry

The Department of Forestry's programs in education, research and extension are unique within the state of South Carolina. As such, the department plays an important role in educating many of the foresters who manage the 12.5 million acres of forest land in the state. This resource is responsible for more than \$4 billion in annual sales of forest products produced by more than 1,000 wood-using industries. Clemson's curricula in forest management and forest products emphasize the role of the forester as a steward of the state's forest resources. Research programs emphasize problem solving and gaining fuller understanding of the forest and its use.

During the past academic year 23 students received the bachelor of science degree, 16 in forest management and seven in forest products. Seven received the master's degree, six in management, one in products. Three received the Ph.D. degree.

Clemson has developed a reputation for sponsoring first-class short courses to update professionals who have been out of school for a number of years. For the ninth consecutive year, Forestry faculty taught a two-week continuing education course to U.S. Forest Service personnel from throughout the Eastern United States. And, for the fifth year, the department sponsored a Forest Service six-week short course on Sale Area Layout and Harvesting. Both courses were coordinated by Extension specialists who likewise enjoy a reputation for quality presentations and information delivery.

Construction began to convert the basement of Lehotsky Hall to space for graduate student offices, a large auditorium for short courses and classes, dry labs and storage. Although most of the renovated space will house the Department of Aquaculture, Fisheries and Wildlife, completion of this project by July 1989 should help ease some of the space problems which have developed in the building over the past few years.

Another major development has been the planning and building of a new \$.5 million Belle W. Baruch Forest Science Institute Laboratory near Georgetown, S.C. This lab, which should be completed in late 1989, will allow the scientists to move into modern facilities. Along with some new personnel in the next few years, this combination of talent and facilities will make the institute one of the premier sites for coastal plain forestry research in the South. With the goal of attracting more outside funding and participation by other scientists in this unique environment, a new brochure has been developed which outlines the programs and facilities available at the institute.



Two faculty, Mr. Reamer and Dr. Zahner, retired this past year. Mr. Reamer will still teach harvesting, and Dr. Zahner will finish some contracts with the U.S. Forest Service for at least a couple of years. At the end of this fiscal year, Drs. Cool and McGregor retired. Dr. Cool had been teaching in the department since 1958. Dr. McGregor, with a distinguished career as first dean of the college and then teacher and researcher, ended a fulfilling commitment to public service.

One of the sadder events of the year was the death of recently retired Dr. Roland Schoenike. Dr. Schoenike's legacy lives on in the Roland E. Schoenike Arboretum (now part of the Clemson Botanical Gardens), which was dedicated to him before his death. Much of Dr. Schoenike's long-term research on chestnut, yellow-poplar and littleleaf resistant shortleaf pine will be carried on by faculty in the department. Finally, his lasting mark on the Christmas tree industry in the region was underscored by the publication of *Leyland Cypress—A Tree of Beauty*, a complete guide to the production and tending of this tree, produced by the department and the South Carolina Forestry Commission.

The faculty spent two days in January developing major undergraduate curricula changes for both forest management and forest products majors. Although it is too early to give details, the general consensus was to offer major option paths which would give more latitude in adjusting a student's interests to a career in forestry. This should attract a broader range of students and provide other courses to take fuller advantage of the range of existing and future faculty expertise. Likewise, recruiting efforts have culminated with the production of a videotape for prospective students. This video outlines the opportunities available in forestry and forest products. Along with the recently developed recruiting brochures and a new forestry scholarship brochure, the department plans to use the videotape to increase enrollment over the next few years. Once the anticipated changes in the curricula are in place, the offerings in the department should be competitive with any similar natural resource program in the country.

One of the highlights in extension over the past year was the development of training materials and a series of best management practices training meetings to educate loggers and foresters on the effects of harvesting and logging on water quality. Also four training meetings were held for builders, architects and building inspectors on the characteristics of wood as building material. Likewise, a \$20,000 grant was used to develop videotapes to inform the above audience as well as homeowners about how to avoid moisture-related wood-decay problems.

Faculty efforts in research during the year were underscored by the numerous publications, most of which were the result of studies supported by state research and federal McIntire-Stennis funds, two major sources of funding. Some of the areas of intensive research ongoing are in wood chemistry, biotechnology, nutrient cycling, silvicultural influences on watersheds, and habitat studies on deer, turkey and fox squirrel. Outside grants totaled more than \$.5 million this past year, a credit to the department's growing reputation for quality research faculty and facilities. During the year Dr. Michael Taras, head of the department, became the 43rd president of the Forest Products Research Society, the international professional organization for forest products specialists.



With regard to programs in research, this past year has also seen some challenges met. The long-range plan for the Clemson Experimental Forest was revised by Dr. Allen and his faculty committee. This effort and final report should result in a Forest with goals that over the long-term cannot be sacrificed to the short-term plans that would compromise this valuable state resource. The acid rain/ozone research site on the Clemson Experimental Forest is now up and running after a year of site development and building. The personnel to carry out this intensive effort are all in place, and the department looks for some major results in concert with the other four sites in the South, which are also studying commercial southern pine species. This major effort sponsored by the EPA and the Forest Service should provide evidence concerning the effects of these major air pollutants on tree growth. Finally, the college has completed a major development with the acquisition of the Springfield Plantation, a 250-acre tropical forest and resort on Dominica. Over the next few years the department will make major decisions concerning the development of a research program in tropical forestry. Because of this site, Clemson now has the opportunity to do research in this vital global issue.

## Parks, Recreation and Tourism Management

### Teaching

Instruction personnel are dedicated to excellence in education at the bachelor's, master's and doctoral levels. Professional preparation for careers in public and private leisure-service agencies include county and municipal leisure services, state and county recreation resource management systems, therapeutic recreation settings, and the broad field of travel and tourism management. Furthermore, preparation at the doctoral level is directed toward research and instruction in academic settings.

Enrollment for the department is shown below:

Undergraduate .....	339 students
Travel and Tourism .....	35%
Therapeutic Recreation .....	11%
Community Leisure .....	7%
Resource Management .....	5%
Undecided .....	42%
Graduate .....	35 students
MPRTM .....	13
M.S. ....	9
Ph.D. ....	13

Highlights within the department's instructional program for the 1988-1989 year included:

- The Ph.D. program has students who have now completed all course work, and the first graduates are expected in August 1989. Ph.D. enrollment is above that projected when the program was proposed.



- Continued course refinement and new course development to reflect adjustments in the respective fields.
- Increase in student credit-hour production reflects an increase in departmental undergraduate enrollment and marketing of PRTM courses to non-majors.
- Adjustments in course offerings by other departments has been taken into account in advising student courses of study.
- Faculty development activities to keep pace with the growing student demand for the travel and tourism emphasis area and recruitment of faculty with expertise in travel and tourism were expanded during 1988-89.

### **Public Service/Research**

Research dollars have been allocated to projects that can be applied to local problems in South Carolina. This is especially true for recreation site planning and developing guides for marketing plans in South Carolina tourist regions. Faculty continue to actively pursue research which will bring national visibility to Clemson and South Carolina. Data from a recreation survey were obtained, allowing Clemson to acquire contracts for analysis of these data. This could lead to recognition as a national recreation data depository and analysis center. Faculty made presentations at nine national and seven regional meetings. Graduate student presentations were encouraged, and presentations by these students representing Clemson were productive. Faculty and graduate students generated 42 publications, with about one-third appearing in national refereed journals. Faculty are continuously requested to serve as referees of research publications and serve on editorial boards of several professional journals. Visibility in tourism research is projected through the Recreation, Travel and Tourism Institute, which has now begun active solicitation of nonappropriated funds to enhance our research endeavors.

### **Public Service/Extension**

The department's commitment extends beyond involvement with undergraduate and graduate students to include a continuing successful program — College Week for Senior Citizens. During 1989 this program served more than 400 citizens from South Carolina and the surrounding region and generated in excess of \$58,000 in gross income. Tourism-related extension activities in FY 1988-89, which had been assigned under the administration of the Recreation, Travel and Tourism Institute (RTTI), were less evident due to a faculty vacancy in the director's position. Professional presentations were given to 19 organizations at the state, regional and national levels. Faculty served on professional boards, editorial boards of national journals and held office in professional associations.

Projects were undertaken for the Anderson YMCA to plan a day camp facility and for the S.C. Law Enforcement Officers Association to develop an area of land for a summer boys camp.

Faculty served on local advisory committees such as the Clemson Chamber of Commerce and the Pendleton Recreation and Historic Society. Classroom projects were used for a variety of community research and planning projects.



## **Outdoor Laboratory**

During 1988-89 use of the Clemson University Outdoor Laboratory increased to record levels. This continued a pattern of growth for each year since the facility first opened.

The greatest growth occurred through service to rental groups from late August through June. The total number of user days increased from 221 to 253 (out of 272 possible days). This represented a daily user rate of 93 percent. The number of individual users declined because of a greater number of groups using the facility for longer periods of time. The impact of several weeks of use by Associated Builders and Contractors, Inc., was the most significant cause for increased daily use, but decreased individual use. Rental income grew more than 33 percent for the year.

The summer camps were at capacity for the 1988 season. Seven residential camps serving more than 800 clients were conducted between early June and mid-August. Nearly 50 Clemson University students and students from other colleges and universities worked with the camps. The summer camps continue to be fully funded by various civic clubs and by camper fees.

The S.C. Jaycees raised \$64,000 for Jaycee Camp Hope. They distributed this amount between the summer operations (\$30,000), Rainbow for Hope (\$25,000), a remodeled infirmary (\$8,000) and smaller amounts to the program. The Jaycees also agreed to raise an additional \$25,000 for Rainbow for Hope.

The Sertomans raised nearly \$40,000 to fully fund 240 children to Camp Sertoma. In April at a statewide meeting, the Board of Directors of Camp Sertoma proposed a five-year drive to develop an endowment for Camp Sertoma with a goal of \$250,000. They also kicked off a \$35,000 project through the sale of individual bricks on the walkway to the Sertoma Pool.

The Lions organization, particularly the Mid-Day Club of Anderson, continues to sponsor Camp Lions Den for the visually impaired. Additionally, they gave another \$1,000 to Rainbow for Hope. Camp Running Brave (for hemophiliacs), Camp Paup-Win (for adjudicated youth) and the Muscular Dystrophy Camp were also conducted at the Outdoor Laboratory during the summer of 1988 and will continue in 1989.

In addition to providing services to user groups for conferences and workshops, the Outdoor Laboratory developed environmental education programs for three local schools. PRTM students were used in leadership capacities to staff these educational programs. Senior Adventure Camp for senior adults was expanded to three weeks, and capacity enrollments were established. Again, PRTM students provided the leadership necessary to make these programs successful.

The Outdoor Laboratory hosted Camp Placement Day in February with 40 participating camp directors. A PRTM graduate student coordinated this event with support from PRTM undergraduate students. Approximately 250 Clemson University students attended Camp Placement Day in the University Union ballroom.

The Outdoor Adventure Course at the Outdoor Laboratory was expanded during the year, and the demand for use increased greatly. Several professional groups use this part of the Outdoor Laboratory for staff development. For the year, 788 participants were recorded, excluding the summer camps.



Rainbow for Hope, the endowment program for the Outdoor Laboratory, experienced a fantastic year. Phase II was announced by Lt. Governor Nick Theodore in July with a total revised goal of \$300,000. At the end of this fiscal year, more than \$350,000 had been raised or pledged. Phase II will conclude in February of 1990.

A recreation coordinator and an associate director of the Outdoor Laboratory were hired during the past year. Each of these positions will allow improved quality of programs and services to laboratory guests. Attention will continue to be focused during the coming year on several additional needs, including road resurfacing, a new maintenance facility, an addition to the superintendent's house and cabin renovation.

### **Professional Development Programs**

Programs and courses have been developed and provided for the U.S. Forest Service Data General Computer Training Program, National Recreation and Park Association, youth computer training program, U.S. Forest Service Recreation Management Division, Army Corps of Engineers, National Park Service and senior citizens. These programs served approximately 800 clients, grossed \$174,000 and were staffed by existing faculty, support staff and graduate assistants, using outside speakers when necessary. Federal IPA assignments were undertaken by these faculty to further Clemson interests and federal projects.

### **Regional Resources Development Institute**

Created in 1981 as the Energy and Resource Development Institute, the Regional Resources Development Institute (RRDI) is a cooperative venture between the Southern Appalachian Research/Resource Management Cooperative (SARRMC) and Clemson University. The institute's purpose is to stimulate and coordinate research in natural resource allocation and management, energy conservation, conflict management over natural resource uses, regional tourism assessment and development, and natural resource policy assessment. RRDI's projects involve scientists and graduate students of SARRMC-member organizations and involve site studies throughout the Southeastern United States. This unique arrangement allows an exchange of ideas and skills between Clemson University and the National Park Service, U.S. Forest Service, TVA, U.S. Fish and Wildlife Service, the University of Georgia, Western Carolina University, North Carolina State University, the University of Tennessee and Virginia Tech.

During 1988-89 the Regional Resources Development Institute expanded its South Carolina: Today and Tomorrow Program to involve other state agencies. The institute finished six agency reports, including a document, "The Living Environment of South Carolina," for the Commission on the Future of South Carolina. RRDI has also initiated a small-town revitalization project through cooperative activities with the South Carolina Downtown Development Association. The first project site is Summerton, S.C. These activities have been possible by an expansion of staff support. RRDI will add three new research associates this summer: a cultural demographer from Texas A&M, a GIS specialist and a youth/community development specialist. The institute was also involved in four workshops, co-sponsoring two.



RRDI funding activities include an evaluation of aesthetic impacts of transmission corridors for Duke Power, \$16,000, completed this fall; a Sea Grant-sponsored Charleston Harbor project, \$20,000; ongoing work with De La Howe to establish a country market, \$80,000 per year. A new community enterprise project associated with another De La Howe project at \$78,000 per year was submitted for funding consideration.

The enterprise program at De La Howe, as the country market has been dubbed, represents a major expansion of the SC: Today and Tomorrow program. The enterprise program is designed to introduce the ideas of small business development to John De La Howe students. Working with the De La Howe School, faculty and students from four colleges at Clemson will help establish a country market in the old dairy barn at the De La Howe store. Students at De La Howe will be given the opportunity to develop products for sale in the market; introduced to techniques for merchandising those products; shown techniques of advertising, cost tracking and inventory control; and be exposed to investment of profits from business operations.

The De La Howe Enterprise project is viewed as a pilot program in alternative education with a leisure modality. The benefits of exposure to capitalism will be assessed as a stimulator for continued education and participation in small business activities. Plans are to extend the De La Howe model to store-front enterprise programs in small towns throughout South Carolina. The retrofit of the barn is slated to begin this summer, with anticipated opening in late summer 1990.

A film depicting the Clemson/De La Howe program is in production and will be completed by late summer 1989.

### **Computer Laboratories/IBM-PC**

The fifth full year of operation for the college's IBM Microcomputer Laboratory was successful. As well as instruction for undergraduate and graduate students in the college, personnel from the National Park Service, USDA Forest Service, U.S. Army Corps of Engineers, Office of Professional Development in the College of Commerce and Industry, Continuing Engineering Education, the National Recreation and Park Association and representatives from private industry used the laboratory for computer skill enhancement. Actual use of the IBM Lab during the past year exceeded 20,000 participant hours.

The first full year of operation for the Data General Computer Training Center logged more than 15,000 hours of computer training time. The Data General Center was established as a cooperative effort between the college and USDA Forest Service and is the only one of its kind in the nation. The center has hosted training programs for Forest Service personnel as well as college faculty and students. The center also supports existing cooperative research and training programs.

Courses within the college have been adapted to provide students with computer application skills pertaining to the management of today's varied and extensive leisure and forestry industries. Eight courses within the college currently offer instruction in computer applications for both undergraduate and graduate students.

Major upgrading of software in the IBM Lab was carried out this year and new software added. A full complement of up-to-date software is now available, including word processing, spreadsheets, databases, statistics, graphics, grammar and telecom-



munications. To enhance the ability of the students to do statistical analyses in the lab, the IBM computers were also outfitted with math coprocessors.

The College of Forest and Recreation Resources is committed to a leadership role in both the leisure services and forestry fields. The utilization and continual improvement of the IBM and DG Computer Labs are important means to maintaining the leadership role.

### **Looking Ahead**

#### *Teaching*

Immediate plans call for a comprehensive review of degree programs. Curriculum issues include:

- Integrate more fully the undergraduate curriculum among the emphasis areas.
- Develop procedures and curriculum enhancement for the graduate program.
- Develop materials and efforts for recruitment of qualified students, with a strong emphasis in minority recruitment at both the undergraduate and graduate levels.

#### *Research*

- Redefine with NPS mission and operation of CPSU.
- Expand work in international arena.
- Utilize existing facilities and operations such as Outdoor Lab and De La Howe project to enhance research efforts.

#### *Extension*

- Develop policies to define what constitutes extension efforts (i.e., state, region, nation; public, private; etc.)
- Define cooperative roles with SC PRT and the department.
- Explore extension opportunities through the proposed media center to be developed in basement of Lehotsky.
- Develop stronger programmatic ties with the Cooperative Extension Service.

## **ACADEMIC AFFAIRS**

### **Clemson University Libraries**

This year has been one of consolidation of collections and expansion of the concept of "library without walls," which was introduced in 1987-88. During 1988/89 the Libraries closed one branch library, opened another and closed one departmental library. Concurrently, the Libraries added five new databases to DORIS and prepared for the addition of two new LUIS databases.

The year also saw a reduction in the rate of inflation for periodical subscriptions, new subscriptions ordered, and additional funds spent on monographic materials and



special microform collections purchased. Another significant event was initial receipt of management reports from the NOTIS system. These early reports will provide information on how the Libraries has been spending its materials dollar, especially for periodicals by academic department.

### Services

The major change in the configuration of the Libraries during 1988-89 was the realignment of branch and departmental libraries. At the request of the College of Sciences, the Libraries transferred the materials in the Physics Departmental Library into Cooper Library. This move took place to provide additional space for the college and to provide better access to the periodical materials housed in Kinard. Relocation of material requires more than the actual move of the volumes. Each bibliographic record must be adjusted to reflect the new location. In addition, the existing collection in Cooper had to be shifted to accommodate the influx of materials. Staff from the Cataloging and Circulation units led the move.

In the spring the Strom Thurmond Institute Building was completed, and the Libraries' Special Collection Unit was relocated into new quarters specially designed for them there. The lower floor was designed to house and service the Libraries' rare books, manuscripts and University archives. The facility has been designed with special air conditioning and humidity-controlled spaces as well as special fire protection. The reading area was designed to provide better control of materials. The major problem with the relocation is that the equipment budget for the new building did not provide for mobile shelving in the stack area, creating immediate space problems for the storage of these unique collections. Again, all of the work that must go into the movement of materials was required, including the adjustment of bibliographic records of the rare books materials. Michael Kohl and the Special Collections staff are to be commended for their hard work to get the collection moved in time for the dedication of the Strom Thurmond Institute Building.

Late in the year the College of Commerce and Industry asked the Libraries to close its Sirrine Library, located in Sirrine Hall. Because of the age of this collection, it was necessary to review each title prior to the move to weed those items no longer of value. A great deal of effort is going into this move because so much of it is to become part of the regular circulation collection of Cooper Library. Again, a number of staff are to be commended for their hard work during this relocation: Ron Williford, branch head, Rhonda Patton, branch assistant, and Mary Lynn Moon, business/textile reference librarian. Members of the Cataloging Unit also are working hard to get as much of the collection accessible as soon as possible.

After all of the realignments during the year, the Libraries division now consists of the main library, Cooper Library; two branch libraries — Gunnin Architectural Library and the Special Collections Library; and one departmental library, the Chemistry Library.

The concept of "library without walls" was furthered by significant changes to the Libraries' online capabilities. DORIS (Document Online Retrieval Information System) underwent major expansion during the year. Five new databases were added; a sixth is nearing readiness and a seventh has been acquired. The Libraries developed



an agreement with Information Access Company to provide five new databases, previously located on microcomputers and CD players, for loading on DORIS. The change from fixed-based databases to DORIS allows greater access to indexing and abstracting tools. As part of our agreement with Information Access Company, the Libraries acquired the magazine collection and business collection on microfilm cartridges along with a Minlota Reader Printer set up to accept these cartridges. These collections complement the five databases added to DORIS, allowing users to go directly to many citations on the microfilm. Although many of the titles in the microfilm collections duplicate hard-copy holdings, the convenience of always having these frequently used titles available has proved to be well worth the cost. Students and faculty have made heavy use of these databases and collections.

A major database, ERIC, was ordered and received during the year. This education database will be widely used, mostly by the students and faculty in the College of Education. That college has made the commitment to continue the subscription in future years. At the end of the year, work was almost complete to make that database available to users on DORIS. Another database acquired was the MARIVE government documents database. This database provides the cataloging records of the government documents distributed to depository libraries since 1976. When this database is made available on DORIS early in 1989-90, much greater access will be available to the U.S. government documents collection. This collection contains a wealth of information and, as in most libraries, has been under utilized because of limited access tools. The addition of a number of printers attached to our public LUIS/DORIS terminals was a big success with users, who now do not have to write down the citations they find on either system.

Some information sources were acquired in the CD ROM format during the year. One of the most popular was the Corporate/CD. This database provides extensive information about businesses. Our Do-It-Yourself searching service continued to be heavily used by students and faculty, particularly graduate students.

A good deal of work also went into providing improved access to the Libraries' collections on LUIS. Keyword access was added, providing a much-improved access to bibliographic records. As a result of adding keyword access and completing the retrospective conversion of printed bibliographic records, the Libraries removed the card catalogs in Cooper Library and all branches. The card catalog had been closed since 1985, meaning no new records had been added since that time. The removal of the card catalogs eliminated confusion of users who, despite signs to the contrary, thought all holdings were included in the card catalog. In addition, LUIS provides access to this information from nearly 2,000 terminals located throughout the campus and around the state. Users can make more effective use of their time by determining, prior to coming to the library, if the title they are interested in is available. Also during the year preliminary work was completed to create two new databases of unique library materials. Work was completed on the creation of a catalog of our 70,000+ slide collection located in the Gunnin Architectural Library and a second catalog for access to the manuscript collections housed in our Special Collections branch in the Thurmond Institute Building. The major tasks remaining for both of these databases are the conversion of the printed records into machine-readable records to actually build these databases.



Preliminary plans were developed to create a new service for the faculty — document delivery. This new service, which will be launched when the fall '89 semester begins, will allow faculty to request, via electronic mail, library books to be checked out to them and delivered to their departmental office. Initially this service will be limited to faculty and to books, but long-range plans look toward expanding it to include staff and photocopies of periodical articles. The library has had some limited experience in this area by providing this service to faculty located at research and education centers across the state for the past several years.

With the financial assistance of the State Library of South Carolina, the Libraries purchased a facsimile transmission machine during the year. This new tool has and will continue to permit the Libraries to considerably reduce the time for receipt of inter-library loan photocopies of periodical articles. In addition, it will allow faster delivery of materials to other libraries. As more and more offices on campus acquire these machines, it will also reduce the time of delivery of materials, library and administrative, to campus departments and offices.

The Libraries' Classified Staff Association provided the initiative for the creation of a library suggestion box and feedback board. This has been well received by users, who not only have an opportunity to share their suggestions and complaints, but also receive a reply to these ideas. It has allowed the Libraries to have a more direct contact with users.

Because of the Centennial year, the Special Collections staff has been busy assisting in research about the history of the institution and providing a large number of exhibits throughout the year. Twenty-two exhibits were created during the year in Cooper Library and the Thurmond Institute Building.

The Libraries had its bibliographic instruction workbook published by a commercial publisher and received the first royalty payments during 1988-89. More than \$1,200 was received in royalty payments from the sale of this workbook used by students in English 101 and 102 classes for instruction in the use of the library and its resources. During the year 324 classes were held for instruction in the use of the library, reaching some 7,200 students.

A major effort was made to provide orientation tours to students as well as the general public. Orientation tours for graduate students were particularly successful.

## **Collections**

Because of the dramatic increases in the costs of periodical subscriptions and the resulting inability to add new titles, a complete analysis of subscriptions was done with widespread involvement of the teaching faculty. As a result some 150 subscriptions costing more than \$100, some costing as much as \$5,000, were eliminated. The savings permitted the Libraries to add more than 300 new subscriptions and to increase the amount of funds available to purchase monographic materials.

As indicated, a major acquisition was the microfilm cartridges from Information Access Co. which have been heavily used and have greatly improved access to many periodicals.

Late in the year the Libraries purchased another major microform collection, the entire U.S. government document collection distributed to depository libraries from



1983 to 1988. This collection will complement the new database covering these items, which was purchased and will be added to DORIS. Now users will know that if they find a citation for a government document published since 1983, the Libraries will have it in either hard copy or microfiche. The combination of these two new resources should dramatically increase the use of this vast and valuable collection.

Another late acquisition was the collection of vendor catalogs and standards on microfilm from the Information Handling Company. This collection, geared to the needs of the College of Engineering, is a major resource, much of which was previously unavailable.

Although the rate of increase for periodical subscriptions continued to be high, it moderated to the extent that funds available for the purchase of monographs increased. This area, which has suffered in the past several years because of the increase in subscription prices, continues to be in need of increased funding.

The Special Collections Unit received a number of significant manuscript collections from noted individuals during 1988-89. Among the papers donated were those of Robert Coker, long-time Clemson University Trustee; Harry Dent, assistant to President Richard Nixon and a key figure in the Watergate affair; Harris P. and Nell Smith, local legislators from Pickens County; and William Penn Mott, outgoing director of the National Park Service.

There were three major events with the Strom Thurmond Collection during the year. These included the initiation of the Thurmond speeches indexing project; more than 1,500 worksheets were prepared for input into the NOTIS system for the manuscript online catalog. On the evening preceding the dedication of the Strom Thurmond Institute Building, Senator Thurmond participated with members of the Special Collections staff in the formal public opening of his papers. The Thurmond Collection, along with the remainder of Special Collections, was moved from the Cooper Library to the specially designed space on the first level of the Strom Thurmond Institute Building.

The Libraries, through the Special Collections Unit, was a participant in two oral history projects. The first was the Centennial Oral History Project, which had 13 interviews with individuals about the history of Clemson University. The second project is with Dr. James Megginson of Drexel University on the history of the city of Calhoun.

The Libraries received two valuable and rare sets of books from Mrs. Henry Fair of Columbia. Mrs. Fair donated *Audubon's Birds of America* (Octavo Edition) and *Quadrupeds of North America* to the Libraries.

## Facilities

As noted, three major facilities changes came as the result of consolidation of two branch libraries and the creation of a new branch in the Strom Thurmond Institute Building. The relocation of the Physics Library and the Sirrine Library into Cooper Library has had a significant impact on the shelving capacity of Cooper Library. This was somewhat offset by the freeing of space with the move of the Special Collections Unit to the Strom Thurmond Institute Building. Nevertheless, Cooper Library continues to have a shortage of seating space. Weekday evenings usually find Cooper Library at capacity. As more and more stacks are required to house the growing collections, additional reading space will be lost until an addition to the building can be constructed.



## Library Use

Use of the Libraries continued to grow. This year more than 216,000 items were loaned to users and more than 792,000 people exited the library. Interlibrary loan also continued to grow. The library is slowly shifting from a net lender to a net borrower, moving toward borrowing more items than lending to other libraries. While there is some status to being a net lender, the reality is that the library is meeting more of the needs of its users, the first priority.

The reference staff continued to receive an increasing amount of reference questions, both in person and by telephone.

## Fund Raising

The addition of more than \$100,000 to the Callie Jones Shirley Library Endowment brings the total of that endowment to nearly a million dollars, with a commitment on the part of the major donor to reach that level in the near future. With the completion of the audits during the year in the Development Office, information on this endowment as well as other accounts in the Foundation have been made available to us. A concerted effort will be made to begin effectively using the income from this endowment.

At least one new President's Club member has designated the Libraries to receive his gift.

A major fund-raising effort of the year was the development of the Library Friends. Near the end of the fiscal year, with the assistance of the staff in Publications and Graphics and the Development Office, a complete solicitation package was designed for the Library Friends, an annual fund-raising opportunity providing operating funds for the Libraries. Having been mailed less than three weeks before the end of the year, the mailer had brought in more than \$12,000 by the end of the fiscal year.

## Staff Development

The Classified Staff Association of the Libraries continues to be an effective body representing the classified members of the library staff. Their leadership in the institution of the suggestion box and feedback board has previously been mentioned.

The Classified Employee of the Year for 1988 was Mrs. Ruth K. Taylor of our Public Documents Unit. Mrs. Taylor is immediate past president of the Classified Staff Association and currently is library representative to the campuswide group.

The Classified Staff Association organized and held a number of training seminars throughout the year.

## Library Statistics

1988 - 1989

Collections				
Books/Journals	Accessioned	Withdrawn	Net Added	TOTAL
Cataloged	22,349	1,693	20,656	684,045
Uncataloged:				
Gunnin				2,154
Sirrine				3,268
				<hr/> 689,467



Documents and Reports .....647,922

Microforms	Microfilm	Microfiche	Microcard	Vol. Equiv.*
Public Documents	1,523	955,310	-----	97,054
Other	20,683	534,986	31,499	77,332
Total	22,206	1,490,296	31,449	174,389

#### GRAND TOTAL

Printed Materials .....	1,511,778
Slides (Gunnin) .....	73,542
Maps (Cooper) .....	16,993

Current Serial Subscriptions	1987/88	1988/89
Periodicals .....	5,811	5,885
Other Serials .....	1,089	1,071
	6,900	6,956

\* Microform volume equivalents are determined by counting microfilm reels as one volume and 10 microfiche or microcards as one volume.

#### Circulation

##### Door Count of Users

Cooper .....	771,290	792,760
Gunnin .....	73,593	74,394
Sirrine .....	n/a	n/a
	844,883	867,154

##### Books Circulated

Cooper .....	218,865	224,744
Gunnin .....	16,109*	34,424
Sirrine .....	10,525	9,342
	245,499	268,510

#### Reference Services

##### Inquiries

Directional .....	3,845	4,963
Reference .....	37,891	48,415
Research .....	489	898
	42,225	54,276

##### Computer Searches

Quick .....	3	3
Do-It-Yourself .....	1,680	1,803
Reference .....	36	117
Research .....	139	151
	1,858	2,074



### Interlibrary Loans

Loaned .....	6,679	6,498
Borrowed .....	6,510	6,700
	<hr/> 13,189	<hr/> 13,198

\* (excluding slides)

## Computing and Information Technology

### Computer Center

The Computer Center's mainframe operations have been located at the Information Technology Center in the Clemson Research Park for more than a year. The new facility has proven to be a vast improvement over the former center on campus in terms of the available space, comfort and reliability of the supporting mechanical systems. The move to the new building came none too soon, as an explosion in early 1989 of the battery backup system in the campus center, would have caused severe problems had the mainframe still been housed there.

The Center's VAX computer systems are now housed in the Poole Computer Center where there is adequate space, power and air conditioning to support them. The equipment is protected by a new uninterruptible power system to replace the one that failed earlier in the year. The VAX network has been considerably expanded in power with the addition of two computers in the 8800 series, obtained in part with a grant of \$800,000 from Digital Equipment Corp. The rapidly increasing popularity of the VAX computers has necessitated an expansion of the Clemson Computing Network to improve access to the network from faculty and staff offices. Center staff have worked actively with a number of departments to install departmental networks that attach to the main network. This raised several issues relating to data security and resulted in the center installing hardware and software to permit encryption of data.

Use of personal computers by students continues to grow. As noted in the last annual report, the center is now concentrating on keeping its existing personal computer laboratories up-to-date rather than on adding new ones. This year has seen a further shift toward the Macintosh computer, with the replacement of the last of the DEC Rainbow computers by Macintoshes. The establishment of the Micro Center as a one-stop department for micro computer sales and support has been an outstanding success. The Micro Center, located in the Poole Computer Center, handles computer sales to students, provides consulting and training services, and manages computer maintenance contracts. The success of this center in promoting acquisition of personal computers by students is vital if the University is to avoid the expense of providing those computers.

The Computer Center has expanded its typesetting services with the acquisition of new equipment. A wide range of typesetting services is now being offered at rates that should enable the University to considerably lower its typesetting bill. Much of what has previously been typeset off campus can now be done by the Computer Center.

In general, computing facilities have kept up with the demand during the year. A mainframe upgrade will be required by the end of 1989, however, if the level of service is to be maintained. The need also exists for the center to offer supercomputer serv-



ices to University researchers and to high technology industries in South Carolina. Clemson cannot expect to be able to compete for scientific researchers or for major scientific research contracts without having a supercomputer available on campus.

Revenue from the sale of mainframe computing services declined in 1988-89 as a result of a change in the accounting model used. There continues to be downward pressure on revenue even though volume of work performed for outside customers is increasing. The cost-recovery method of charging relates revenue to the percentage of work, which is revenue generating rather than its absolute volume. Therefore, if campus computing increases at a faster rate than the revenue-generating off-campus computing, revenue will decline.

The Computer Center has continued to provide the best in computing service to its faculty, staff, students and outside customers. There are major challenges ahead, however, if this level of service is to be maintained. The University's commitment to computing must be reaffirmed with a major new investment in its computing facilities and an increase in the base level of operating support. Outside revenue can make the difference between an adequate computing facility and a great one, but it cannot be relied on to indefinitely make inadequate funding adequate.

### **Information Systems Development**

Information Systems Development (ISD), a self-supporting computing service and research group within the Division of Computing and Information Technology, has just completed its seventh straight year of increased revenues. Revenues were up 30 percent over 1987-88 despite increased competition for contracts and ISD's inability to pay competitive salaries.

ISD continued to generate a large proportion of its revenues from contracts with the S.C. Department of Social Services (DSS) and with the Health and Human Services Finance Commission (HHSFC). The DSS contract will continue on a reduced basis through 1988-89, while the HHSFC contract comes up for renewal that same year. ISD expects to replace the DSS contract, which is for development of a Title IVD Child Support Enforcement System, with contracts for similar systems in other states. ISD has teamed with a commercial company to submit a bid for such a system to the state of Utah and expects to bid on similar systems elsewhere.

ISD's contract to develop and install a home health care software system and computer network for the S.C. Department of Health and Environmental Control (DHEC) has just completed its second year and has been renewed for a third. This system has attracted interest among hospitals and other health care organizations and is expected to yield additional contracts. The relationship between ISD and DHEC continues to expand and is expected to continue for several years.

The S.C. Department of Corrections has provided ISD's latest major contract. ISD is working with the department on a major overhaul of its data processing systems, and again, this is expected to be a long-term relationship.

The increasing demand for ISD to perform research and development services for industry has led to the formation of a research group within ISD. In 1987-88 ISD employed six faculty members and six graduate students on R&D projects for industry. This is an area that will be stressed in the coming years.



The ability of ISD to offer competitive salaries to its employees will be key to its future success. The organization has reached a size where it can compete for major software development contracts, but it must be able to hire and retain the staff it needs. Since ISD generates the revenue to pay competitive salaries, the problems are bureaucratic and not economic. Assuming this problem can be overcome, ISD's future is bright.

### **Administrative Programming Services**

Administrative Programming Services (DAPS) develops and supports information systems for all areas of Clemson University. DAPS provides services to all members of the campus, and during the past year almost 20,000 students, faculty and staff used online information systems supported by DAPS.

A major thrust in recent years has been to provide direct access to the wealth of information stored in the University's databases. Clemson has developed a wide range of integrated administrative databases that can be accessed with many online tools. For example, academic departments have access to the records of students in their departments with either the Departmental Access System for more structured queries or the Intellect natural language query system for ad-hoc, less-predictable questions. Clemson employees and students have direct access to their own employment and academic records through the Employee Information System and the Student Information System. During 1989 the second phase of the library automation system was fully implemented. DORIS, an information retrieval system using the powerful BRS/SEARCH software package, now provides access to a wide range of local and national databases from anywhere on the Clemson computing network. The tremendous success of library information systems will be presented in a book to be published in July 1989 by EDUCOM, a consortium of universities that promotes the use of information systems in higher education.

Besides the development of traditional information systems, DAPS has developed and tested a software product to enable the campus to move toward electronic forms. The new Electronic Forms Management System will be used next year in the new purchasing system as well as the existing employee leave system. It will allow documents to be created and routed through administrative channels electronically, ultimately finding their way to the appropriate computer system for official processing.

DAPS provides database administration across all systems. Clemson's administrative systems are thus tightly integrated and coordinated, and the University has experienced little difficulty in coordinating and reconciling information from the various databases.

This was the tenth year that DAPS assembled and followed the information systems plan. This plan, developed in cooperation with key staff in each vice-presidential area, states specific goals for the upcoming year and tentative goals for future years. By following this plan closely, DAPS has developed an average of three major systems each year since its inception.



## **The Graduate School**

Two new graduate programs were approved by the Commission on Higher Education in the 1988-89 year: the M.S. degree in architecture and the M.S. degree in animal physiology. The Master of Agriculture degree was reinstated after a year's absence, during which significant restructuring and consolidation occurred.

Completed applications for enrollment in the fall semester 1988 totaled a record 3,098. Interest in business and the social sciences characterized a significant portion of the domestic applicants while engineering and the physical sciences dominated the international students' interests. Approximately 52 percent of the pool of applicants were accepted, resulting in 807 new enrollees. The total-enrolled headcount was 3,139, of which 1,375 were full-time students. Females constituted 46 percent of the total enrollees and 29 percent of the part-time enrollees.

A total of 701 graduate degrees were awarded in the period August 1988 - May 1989; 631 master's, three specialists and 77 doctorates.

Plans were initiated to put in place a program to improve the effectiveness of graduate assistants involved in instructional activities. Particular emphasis will be placed on assuring competency in spoken English. This program will be continued and improved for the mutual benefit of undergraduate and graduate students.

## **The National Dropout Prevention Center**

Established in 1986, the National Dropout Prevention Center (NDPC) continues its mission of raising national awareness of the dropout problem and collaborating with individuals and organizations involved in dropout prevention.

The center falls under the administration of the Provost's Office and is affiliated with the National Dropout Prevention Fund, a board of business and industry leaders concerned about the impact of the dropout rate upon the nation's future. The fund provides advisory and support resources for the center's activities. The relationship between Clemson University and the National Dropout Prevention Fund have made the center a true business-education partnership.

The NDPC also maintains a relationship with the National Dropout Prevention Network for whom it acts as host agency. Through collaborative efforts of the network and the center in the past year, network membership has increased to more than 2,000 school practitioners, researchers and policymakers.

The center believes that in order to lower the dropout rate in American schools several factors must be present. First, causes of the dropout crisis must be identified and communicated. Secondly, technical assistance and expertise must be combined and applied to the situation. Finally, programs and products must be created and distributed to initiate and sustain positive change.

### **Awareness Raising**

Throughout last year the NDPC publicized the severity of the dropout issue and the ramifications of an under-educated populace.

Within South Carolina the NDPC has (1) co-sponsored a national conference on dropout prevention, which attracted more than 300 educators and policymakers from



across the nation; (2) co-sponsored a second state forum in which 100 school counselors and 150 students discussed the dropout issue; (3) presented testimony, which included the latest dropout statistics and program recommendations to the Governor's Council on At-Risk Youth; and (4) coordinated through the SC Network (established by the NDPC) and SCETV 20 viewing sites for 800 participants across the state for the national teleconference, *"America's Shame, America's Hope."*

The center has worked diligently to publicize the dropout issue across the nation. It has (1) collaborated with the network to plan and promote the first National Dropout Prevention Conference in San Diego, which attracted more than 1,800 participants from across America; (2) participated with the National Dropout Prevention Fund, which hosted a gala dinner to alert business and community leaders to the dropout crisis and to underscore their roles in prevention; (3) coordinated 130 viewing sites in 45 states for the national teleconference *"America's Shame, America's Hope;"* and (4) distributed information on dropout prevention through print and broadcast media. The NDPC has been recognized and used as a reliable source by *The New York Times*, *US News and World Report*, CBS News and CNN. In addition, the center has participated on nine radio shows from Seattle to Washington, D.C., and has been quoted by many local and regional newspapers.

### **Technical Assistance**

Awareness must be followed by action. The NDPC has provided those interested in reducing the dropout rate the technical assistance and expertise required to bring about change.

The center has (1) conducted grant-writing workshops for S.C. school administrators; (2) assisted 33 S.C. school districts and regional organizations seeking federal funding (two districts received \$1.2 million); (3) awarded two S.C. school districts grants from which model dropout prevention programs will be developed and implemented in collaboration with the NDPC; (4) utilized center staff and a vast network of South Carolina and national contacts to respond to more than 250 requests per month for information, materials and services; (5) established an on-site materials resource library containing the most current research, promotional and educational information on dropout prevention; (6) served as a member of the University's Task Force on Youth for the Kellogg Foundation; (7) provided data and documentation to the S.C. House of Representatives Education Committee regarding Target 2000 legislation, in addition to serving on 12 other national and state advisory boards to shape program policies; (8) coordinated a meeting of representatives from several major institutions of higher education to collaborate on dropout prevention strategies and activities; (9) conducted national conferences, workshops and skill-building sessions for educators and administrators; (10) developed a network of at-risk coordinators in all 50 states; (11) provided staff as presenters at 15 national and state-wide conferences and in numerous local school district staff in-service programs; and (12) collaborated with the National Dropout Prevention Network to organize and distribute current information relating to dropout prevention activities and strategies.



## **Products and Services**

The NDPC has created a number of products designed to help bring about and support the process of change. NDPC publications like *Solutions and Strategies* address timely topics in dropout prevention. *Dropout Prevention Research Reports* provide more in-depth study. Research report topics presently under production include "Mentoring Programs for At-Risk Students" and "Evaluation of At-Risk Youth." *So You Want to Drop Out of School . . . You Ought to Know the Facts* is aimed toward at-risk students and gives them a realistic look of their future without a diploma. *Dropouts: The Principal's Role* offers practical advice and guidelines for identifying and helping at-risk youth within a school system.

Additionally, the center distributes statewide a quarterly newsletter, which profiles programs and policies affecting South Carolina. Its circulation consists of approximately 1,500 legislators, school superintendents, attendance supervisors, network members and other interested individuals. It is distributed in conjunction with the nationally oriented publication, *The National Dropout Prevention Newsletter*, which profiles successful model dropout prevention programs, the most current dropout prevention research and literature, as well as organizations working with at-risk youth. This newsletter is distributed each quarter to approximately 5,000 recipients among whom are educators, administrators and policymakers.

FOCUS, the NDPC's easy-to-use database composed of dropout prevention program profiles and a calendar of events, has expanded to include more than 300 profiles. This database is now available throughout the United States to individuals with a modem and personal computer, providing easy access to dropout prevention data.

## **The Strom Thurmond Institute of Government and Public Affairs**

The Strom Thurmond Institute is the main program component of the Strom Thurmond Center for Excellence in Government and Public Service. The institute conducts five programs:

- The Thurmond Seminars in Government and Politics
- The Strom and Nancy Thurmond High School Achievement Program
- Institute Lecture Series
- Distinguished Lecturers Program
- Public Policy Research Program

The Strom Thurmond Institute Building was dedicated April 22, 1989. An estimated 3,500 persons attended the dedication ceremony and heard U.S. Vice President Dan Quayle deliver the keynote address.

## **Public Programs**

During 1988-89 the institute presented 42 speakers in a variety of forums ranging from individual lectures to seminars on selected topics.

The institute offered its second annual series of regional seminars in energy emergency preparedness planning, holding sessions in Mississippi, Connecticut, Michigan, North Carolina, Nebraska and Washington state.



The Strom Thurmond Seminar in Government and Politics for Social Science Teachers was offered in June 1989 for the seventh year on the Clemson University campus and in Washington, D.C., at Georgetown University.

The institute sponsored its fifth annual Conference on Volunteerism in October 1988 in Myrtle Beach. The conference was attended by more than 200 persons representing more than 50 different non-profit organizations in South Carolina, North Carolina and Georgia.

### **Policy Research**

From July 1, 1988-June 30, 1989, the institute entered into research contracts totaling \$590,000. These included a continuing contractual arrangement between the institute and the South Carolina Water Resources Commission in the amount of \$110,000 for continued work in developing a state water policy.

The institute concluded in February 1989 the Anderson County Needs Assessment Survey and conducted two local growth policy/land use studies for the city of Clemson and Pickens County, respectively.

The Institute has received funding from the South Carolina State Development Board to assist in the development of a Geographic Information System for the state. The contract is in the amount of \$165,000, which includes a \$15,000 matching grant from Clemson University's Cutting Edge program. This work, done in cooperation with the Appalachian Regional Council of Governments and the State Development Board, will span 18 months.

The institute received in March 1989 a grant from the Office of the Governor to develop a computerized school bus routing program. The \$174,000 grant will fund work over a three-year period beginning in January 1989.

The institute is cooperating with the U. S. Department of Energy in offering regional seminars throughout the United States on energy emergency preparedness planning and in the development of a research and program agenda for energy emergency preparedness policy.

The institute published seven major project reports, 10 working papers and related project documents, two lectures and three symposium proceedings during 1988-89. The institute also published *The Strom Thurmond Institute: The First Six Years, 1982-88*.

Institute publications were distributed to approximately 10,000 persons, organizations and institutions, including business organizations, government agencies and public officials, libraries and research organizations.

### **Other Activities**

The institute continued its support and working relationship during the year with the National Dropout Prevention Center and continued involvement in the arrangements for receiving the gift of Springfield Plantation in Dominica for establishment of the John Archbold Center for (Wet) Tropical Studies.

### **Activities for 1989-90**

In the future the institute will continue to offer the public programs within its original charge, consistently observing high standards of quality in the programs presented



and observing the policy of nonpartisanship. In the area of public policy, the institute will continue to focus its efforts upon (1) community development and (2) serving as a means of transferring the important scientific and technical work being done at Clemson University to solve problems and meet needs in the public arena. It is expected that during the 1989-90 academic year, the institute will broaden its activities in certain public policy areas, mainly from the standpoint of research and public service.

### **Undergraduate Studies**

The Undergraduate Studies Office is responsible for undergraduate academic programs and curricula, academic standards, scholarships and awards, University-wide lectures, new faculty-staff orientation, summer sessions, the Clemson Career Workshops, the Junior Scholars Program, the Calhoun College honors program, Cooperative Education, special post-graduate scholarship programs and the Clemson University Centennial.

The Clemson Career Workshops bring academically outstanding minority students to campus before their junior and senior years in high school. The 1989 summer program included 75 students at both levels. Clemson expects approximately 50 new freshmen recruited by this program to enroll in the fall of 1989.

The honors program enrolled 5 percent of the undergraduate student body in 1988-89. Fifty students were graduated with senior departmental honors in December, May and August. Two Clemson seniors received Fulbright Scholarships for foreign country study in 1987, bringing the number to 31 in the past nine years.

Cooperative Education moved to Undergraduate Studies in 1988. This year the program enrolled 600 students whose earnings during their work period were \$4,500,000.

The Junior Scholars and Summer Science and Engineering Programs bring academically talented students who are between the ninth and twelfth grades for the Summer Academic Enrichment Program. The program, which is in its fifth year, enrolled 300 students this year.

The Centennial had two focuses—science and economics—during the 1988-89 year. John McKetta, distinguished chaired professor of engineering at Texas, was the lead speaker for the science focus. The economics focus began with a dinner — A Report to the People — honoring the state government's role in Clemson and Clemson's response over the 100 years. Nobel Laureate George Stigler was the chief on-campus lecturer in the focus. The Centennial will conclude November 27, 1989.

### **DIVISION OF ADMINISTRATION AND SECRETARY OF THE BOARD OF TRUSTEES**

The Division of Administration was created August 1, 1985, in conjunction with the secretary of the Board of Trustees. The fundamental responsibility of the Administration Division is to formulate, monitor and coordinate fiscal matters for the Office of the President as well as other areas of University administration. The vice president



for administration assists the president in discharging his general administrative and executive functions and represents the president during his absence. The secretary of the Board reports directly to the Board of Trustees. He records all proceedings of the Board and Board committee meetings, is the custodian of the University seal and all records of the Board, and performs other duties as may be assigned by the Board of Trustees. Division expenditures for the fiscal year ending June 30, 1989, were \$2,846,580.

The director of public safety, who supervises the police and fire departments, reports to the vice president for administration. The assistant vice president for human resources is supervised by the vice president for administration. During this year, the Office for Human Resources has developed the Center for the Study of the Black Experience in Higher Education. The internal auditor is responsible to the secretary of the Board of Trustees, who, in turn, reports directly to the chairman of the Board. The University municipal judge relies on this vice president for administrative and logistical support. The Department of Parking and Vehicle Registration, which is an auxiliary department, is under the cognizance of the vice president for administration. The Administration Division has the responsibility for overseeing the Office of Public Affairs.

### **Fire Department — Emergency Medical Service**

During 1988-89 the Fire Department responded to 484 fire alarms compared to 451 the previous fiscal year; 28 percent of the alarms were off campus. Three hundred forty-five emergency medical alarms were answered. A total of 2,117 man-hours were spent responding to emergencies.

Serious incidents on campus included a fire in the attic area of Harcombe Dining Hall during the Christmas holidays, a dormitory room fire during a renovation project in Mauldin Hall and a batterybank explosion in the basement of the P&A Building. Off-campus alarms included mutual aid assistance to the cities of Seneca and Central and numerous single-family dwelling fires within the city.

On-campus fire property damages for this reporting period totaled \$80,650. Property damage in the city of Clemson was \$126,500. A total of \$2.4 million of endangered property was saved by CUFD-EMS fire ground operations.

Four civilians and two firefighters were injured by fire-related alarms during the year. Two additional firefighters sustained injuries during non-emergency activities. There were no fire-related fatalities on campus or in the city.

Fire prevention activities of officer Tommy Tucker have resulted in the correction of several chronic problems in campus buildings. A designated fund under the control of Facilities Maintenance and Operations has been established to accomplish improved fire and building code compliance in existing buildings in 1989-90.

A film depicting the importance of evacuating dormitory buildings when the fire alarm system activates was produced by the CUFD-EMS under F.S.O. Tucker's direction. The 20-minute story, "Charlie's Last Day," includes live film footage shot at the CUFD-EMS Training Center and Johnstone Hall using University students and fire fighters. The University's Communications Center filmed the project. More than 200 requests from campuses and fire departments around the country for "Charlie's Last Day" have been received and filled.



Increased awareness of dormitory fire safety has resulted in a steady decline of malicious false fire alarms, fire system vandalism and resident violations written for failure to evacuate when a fire alarm system activates.

Three thousand eight hundred fifty-five man-hours were spent in training by CUFD-EMS firefighters. In addition to fire suppression skills, personnel received monthly training in hazardous materials by Captain Lew Riley and monthly D.H.E.C. approved emergency medical training.

Personnel turnover during 1988-89 was 5 percent (one firefighter joined the Division of State Fire Marshal's Office). An eight-week recruiting effort to attract a qualified minority candidate to fill the opening was unsuccessful. Fire Chief Jack Abraham is recruiting minority candidates for volunteer firefighter openings, which should improve the likelihood of minority representation on the CUFD-EMS in the future.

The CUFD-EMS again led all upstate fire services in South Carolina by raising in excess of \$5,800 for muscular dystrophy during the past year. Captain Kenny Charles coordinated the fund-raising efforts, which included a roadblock and golf tournament.

Members of the CUFD-EMS represented the University and the department by making presentations at an international fire chief's conference in Washington, D.C., a state fire inspector's conference in Myrtle Beach, the Southeastern Fire School and local television networks.

## **Human Resources**

The Office of Human Resources coordinates and directs the University's affirmative action and desegregation plan efforts. The department is actively involved in recruiting black faculty, staff and graduate students, mediates pre-grievances based on alleged illegal discrimination, conducts an educational and counseling program for sexual harassment, is responsible for state and federal statistical reporting, and develops projects to meet the objectives of equal opportunity and desegregation.

In the past year the department was instrumental in establishing and developing the Center for the Study of the Black Experience in Higher Education, a resource for information, research and programs on factors affecting the educational decisions of blacks.

The department also put on a national conference, "Vital Issues II: Racism, Prejudice and Separatism in Higher Education," which attracted higher education administrators from across the country.

## **Internal Auditing**

The staff of the Internal Auditing Division consists of eight members: a director, an audits manager, an ED audits manager, three staff auditors, an accounting technician, and a half-time word processing operator. The director reports administratively to the secretary of the Board of Trustees.

The division provides an ongoing, independent audit function for the University as a service to management. Audit parameters include financial, compliance and operational review, as well as special requests.



## **Municipal Judge**

The staff of the University's Municipal Court consists of two judges, one full-time judge who serves as the department head, and one part-time judge who serves in the absence of the chief judge and on weekends and special occasions. Also, the staff includes a clerk of court and one student secretary. Formerly known as the University recorder (Recorder's Courts were abolished in 1980 by act of the General Assembly), the judge for the municipality of Clemson University hears appeals and renders decisions on all campus parking violations brought before the court, tries all persons charged with violating any ordinance passed by the Board of Trustees and any state laws that fall within the jurisdiction of the municipal judge (any crime or traffic violation for which the maximum penalty that can be imposed does not exceed \$218 or 30 days in jail). The municipal judge also issues bench warrants, search warrants and arrest warrants for incidents arising on campus.

## **Parking and Vehicle Registration**

The Department of Parking and Vehicle Registration is responsible for managing the parking program for Clemson University. This responsibility includes maintaining parking spaces and lots, planning and implementing construction of new parking lots, vehicle registration and maintenance of parking violation records. For 1988-89 the department issued 19,842 decals and deposited \$182,452 from the sale of decals. For the same period 53,019 parking citations were issued by the University Police Department, generating \$519,338 in revenue.

A shuttle bus operation was begun by the department during fall 1988. The shuttle bus operation consisted of five 15-passenger vans that were rented from the University Motor Pool. Drivers included students and crime security officers. The shuttle service operated during the fall and spring semesters and transported approximately 106,000 riders. Cost for the service, including drivers and van rental, was \$50,023.81. The average number of riders per day was 592, and the average cost per rider per day was \$.47.

## **Police Department**

During 1988-89 the Police Department responded to 6,079 calls for service, a 3 percent decrease from last year. Crime rate statistics reported in *SLED's Crime in South Carolina 1988* indicated a 9.4 percent increase in violent crimes and an 8.6 percent increase in non-violent crimes reported at Clemson University in 1988. During this same period crime reported in Pickens County increased 11.5 percent and 11.2 percent in violent and non-violent crimes, respectively.

Police efforts during the year resulted in 271 arrests and \$16,725 in fines resulting from convictions and \$37,024 (14.5 percent) of stolen property recovered during the first 10 months of this year. The department provided services for 153 special events on campus in addition to normal activities.



### **Investigative Division**

The Investigative Division assembles facts and evidence to document a reported incident, identify offenders and assist in the administration of justice. This division also performs background investigations, coordinates the protection for VIPs on campus when requested and helps present public safety programs. During 1988-89 the investigators operated with an average case load of 191 cases. Investigator Mac McCrary serves as vice president of the S.C. Campus Law Enforcement Administrators organization. Significant accomplishments of the division include:

- Investigated an embezzlement case, which should ultimately result in the return of \$22,500 to the University.
- Recovered stolen property including two vehicles.
- Completed investigation of the Calhoun Mansion fire, which resulted in two arrests and subsequent guilty pleas.
- Provided dignitary protection for six campus visitors and participated in protective efforts for the vice president of the United States during his visit.
- Provided 85 background investigations for University departments.
- Supervised the activities of Pre-Trial Intervention participants, who provided 583 hours of public service to various University departments.
- Provided in-service training to investigators in various topics, including homicide investigations, dignitary protection, constructing composites by computer and legal update.

### **Uniformed Patrol Division**

Uniformed patrol officers move about campus to deter and detect criminal activity, preserve order, direct traffic, investigate accidents and enforce state laws and University parking regulations. Additional services include transporting sick/injured students to the infirmary, monitoring intrusion and fire alarms, providing dispatch service for fire and EMS, evening dispatch service for Facilities Maintenance Operation and maintaining traffic signs and street markings. During this year an evening escort service was initiated. Students may request the service by calling the Police Department. Significant accomplishments of the division include:

- The traffic safety program provided defensive driving instruction to 485 campus citizens, trained an additional instructor, improved the in-service training program for officers in emergency vehicle operation and issued 1,343 traffic citations resulting in fines totaling \$43,255.
- Parking enforcement efforts resulted in 53,019 citations issued, which generated \$519,338 in fines. The additional parking enforcement officers planned for 1989-90 and the additional use of computer ticketing machines are expected to provide parking enforcement services that are more effective and uniform throughout campus areas.
- Preventive patrol efforts were enhanced by the additional walking hours assigned to patrol officers and the temporary addition of contract security officers assigned to walking beats.



- New police cars with high-visibility strobe warning lights have increased the officers' safety when working accidents and enhanced the morale and efficiency of the division.
- In-service training was provided to personnel in a variety of modern police procedural topics. Additionally, one officer completed basic certification; five radar operators and two breathalyzer operators were recertified. New legislation mandates minimum in-service requirements for all certified police officers.

### **Administrative Division**

The Administrative Division is responsible for developing and presenting public awareness programs, supervising student police officers, and working with victims of crime by providing services and information to help them cope with the criminal justice system and with the stress caused by victimization. Significant accomplishments of the division include:

#### *Public Safety Programs and Services*

- Provided safety programs to more than 2,000 campus citizens.
- Completed security surveys for more than 95 percent of University departments.
- Performed security surveys requested for 29 secondary education facilities in Pickens County. The Campus Security Liaison Program resulted in an award being presented to the department by USC Innovations in Law Enforcement.
- Submitted a paper on "Crime Prevention in the 1990s," which was selected by the International Association of Campus Law Enforcement Administrators for presentation to their audience.
- Received two grant awards. One allows the department to use the latest computer technology to construct composites of criminal suspects and the other provides a full-time victim/witness advocate to enhance the Victim/Witness Program.
- Performed computer composites using the new system for eight campus crimes and 15 crimes committed in other jurisdictions, including the Lander College homicide and the April Hensen kidnapping in Spartanburg.
- Provided services to more than 200 campus citizens in the seven months that the victim/witness advocate has been utilized. The grant allowing for program continuation has been extended through the coming year.

#### *Student Police*

- Student police officers provided 1,566 hours during special events, 1,115 hours painting street markings, 956 hours of special surveillance, and 5,789 hours for athletic events, traffic direction, parking enforcement, dispatch and VIP transport services.
- The number of student officers participating in the program declined, possibly due to off-campus employment opportunities paying higher wages.



### *Crisis Response Team*

- Training topics for the team during the past year included search and rescue, crisis negotiations, command post operations and strategic reaction team training.

The close of this year finds the department working toward development of software for Uniform Crime Reporting. The challenges of the future include planning for the replacement of our communications equipment, additional computer programming and being prepared to meet the public safety needs of an increasing on-campus population.

### **Public Affairs**

The Office of Public Affairs maintains contact with the S.C. General Assembly and state regulatory agencies. The president is provided counsel and advice on activities of the General Assembly by the director of public affairs.

A continuing task for the Office of Public Affairs is to maintain a University presence in the capital city by serving in a liaison capacity with central state government. Furthermore, this department is committed to enhancing the image of higher education with the legislative and executive branches of state government and the public.

## **BUSINESS AND FINANCE**

Business and Finance is responsible for determining the broad policies of institutional functions relating to administration, business and finance, and for managing specific administrative, fiscal and auxiliary functions. These departments are comprised of more than 1,000 full-time, part-time and contract employees responsible for managing financial resources in excess of \$72 million.

During 1987-89 Business and Finance was reorganized, consistent with the organization's strategic plan. The following are highlights of the goals achieved in 1988-89:

### **Governmental Relations and Communications**

Working in cooperation with other members of the campus community, Business and Finance helped enhance Clemson's relationships with a variety of Clemson constituencies. Members of the Business and Finance organization stepped up their efforts to establish and renew contacts among strategic state agencies. Communications with members of the Joint Bond Review Committee have been improved, particularly in the facilities area. Progress has also been made in establishing contacts and relationships with respect to budget and procurement issues. An interadministrative team produced the second annual award-winning *President's Report*, as well as the first annual *Research Report* for the Office of the Vice-President for Research. A supplement to the new financial report was also published.

Efforts to improve communications with a broader cross-section of the University were also made. A *Management Letter* was initiated to inform the campus about faculty salary and compensation issues, budgets, formula funding, and Business and Finance



division accomplishments. A newsletter, *CUnite*, was initiated by Business and Finance to keep the campus informed about three processes important to the future of the University: strategic planning, the upcoming self study for reaccreditation and assessment of institutional effectiveness. The first edition of the University's *Fact Book* was produced and distributed by the Office of Institutional Research. A budget analysis fact book was produced for Universitywide distribution.

Special meetings have been held with academic department heads and individual faculty to encourage discussions on a broad range of budget, research and personnel issues.

### **Strategic Planning**

Business and Finance's first strategic plan was produced and presented at the president's retreat in the spring, and an update of the campus master plan was initiated. Academic departments received assistance in integrating their Second Century and other plans with annual budget priorities. The conceptual framework and process for enhancing Universitywide strategic planning were presented to the administration and approved, and consultants were engaged to speak and present workshops at a kickoff conference on "Strategic Planning, Self Study and Assessment" in March and on "Environmental Scanning and Futures Research" in June. Assistance in facilitating strategic planning and environmental scanning and futures research was provided to faculty committees engaged in Second Century strategic planning. The division also assisted academics in preparing for the upcoming SACS accreditation review.

### **Budget Systems**

Clemson began its second century of operation with a budget exceeding \$300 million for 1989-90 — an increase of \$45 million over fiscal year 1988-89. Higher education institutions received only 91 percent formula funding, compared to 93 percent in 1988-89; Clemson's share amounted to a \$11.7 million increase in state appropriations. The state of South Carolina continued its commitment to funding higher education research, scholarships and other programs by investing \$5 million in Cutting Edge funds.

The University has strengthened its financial foundations by working toward integrating long-range planning priorities with the budget process. Block funding, an innovative approach to allocating operating and equipment funds, was introduced to the campus for the first time this year. This approach shifts more fiscal responsibility and flexibility to the colleges and divisions.

The Clemson University Innovation Fund was established to provide resources for unique ideas that otherwise might not be funded and to provide incentives for new initiatives and programs. An Innovation Fund Awards Committee was established to review and evaluate the merits of submitted proposals, and guidelines for the Innovation Fund were distributed throughout the University.

For the first time, the budget office submitted the annual state detail budget request in electronic spreadsheet format. An FTE tracking system has also been established. The first annual *Budget Analysis Fact Book* was published in July 1989.



## **Sponsored Programs**

The Office of Sponsored Programs Administration is responsible for administering resources received through sponsored programs (contracts, grants and cooperative agreements) in a manner consistent with prudent fiscal policies, sound management practices, and all policies, procedures and laws regulating such activities. FY 1988-89 sponsored program awards again showed substantial increases from the previous year. While final FY 1988-89 figures have not yet been determined, awards are expected to exceed \$23 million. In addition, expenditures in excess of \$16 million are anticipated.

The Institute of Wildlife and Environmental Toxicology moved to Clemson University from Western Washington University in May and has already generated \$1.7 million in new external funding. In addition, Clemson is among the three finalists for two major programs that would total \$110 million if funded. One program is in composite materials (\$40 million) and the other involves supercomputing (\$70 million).

## **Business and Financial Affairs**

This program area includes providing the campus with goods and services through financial management, various auxiliary enterprises, transportation services, purchasing and supply services, and various management and financial support services. Emphasis during the year has been to eliminate or reduce paper flows for the campus and the Business and Finance area by evaluating policies and procedures, reporting mechanisms and internal controls. Projects were implemented to track lapsed salary savings, update the Business and Finance Manual, produce reports for campus distribution on travel policies and a guide for department heads, evaluate various accounting and reporting systems, and determine the campus exposure to unrelated business income tax.

## **Student Registration**

In cooperation with Student Affairs, a number of improvements to the student registration process have been implemented. Registration has been centralized, and Guaranteed Student Loan (GSL) distribution has been relocated to a larger area in Martin Hall to facilitate the flow of students through Sikes Hall. Other improvements under consideration include on-line fee assessment and on-line cashiering to include the issuing of receipts to students for payment of fees.

## **Accounting for Related Organizations**

As a culmination of several months' work, all related organizations — the Clemson University Foundation, the Clemson Alumni Association and the Clemson University Research Foundation — began converting to a new accounting system in January 1989. The system was designed to provide improved controls, supply more useful information for management and enhance conformity with accounting principles for non-profit organizations. Training sessions were held for department personnel to inform them of the new procedures.



### **Purchasing and Supply Services**

Purchasing serves and supports the entire University in the procurement of goods/services, information technology, consultant services and construction.

During FY 1988-89 the Purchasing Division issued 1,128 bids and processed 6,833 purchase orders at a value of \$41.4 million. Various agency contracts have been established to allow volume buying and a reduction in processing time.

Efforts continue to increase procurements from South Carolina minority and female-owned firms. Total expenditures in this area for fiscal year 1988-89 were \$480,371, representing 3 percent of controllable dollars.

The University Receiving Station processed 69,617 incoming shipments. The University Stores operation processed approximately 30,000 orders during this period.

Due to changes in the procedures governing the disposal of surplus property implemented by the state, the Property Control Section will no longer have public auctions. Items declared junk by the state surplus property officer may be disposed of by sealed bid or be discarded. Four sealed bid sales during 1988-89 yielded \$13,413. Clemson University has received \$27,885 from the state for the sale of excess property.

### **Accounting**

Accounting has made a concerted effort to evaluate and reduce the paper flow involved in the accounting processes. This has been a joint effort with other departments on campus.

The development and implementation of the Use Tax System will allow use tax to be charged at the time a payment is made. This change will eliminate the cumbersome paper process and will save the Accounting Department and each department on campus a substantial amount of clerical effort.

The procedures for the accounting and authorization of internal charges are being modified to eliminate the duplication of work in the approval and data entry process.

A Purchasing/Accounts Payable system is being developed that will use an electronic computer form which will replace the current paper system of vouchers with manual authorizations. Once this phase of the system is implemented, other disbursement documents will be added to the electronic forms process.

## **Auxiliary Services**

### **Dining Services**

Participation in the University's dining services increased by approximately 800 people in FY 1988-89. More than 8,800 students participated during the year. The canteen was renovated and improved to provide quick food service as an alternative to the dining halls. In 1988-89 students were offered the use of a declining balance account, which could be used (same as cash) in any food service location. A variety of new dining options, including renovations to the Clemson House, are being implemented for Clemson students.



### **University Laundry**

The laundry continued to modernize by adding new equipment during the year. Renovation of the front of the facility and enhancements to the cooling system are planned during the coming year.

### **Transportation Services**

In an effort to centralize transportation services for the campus and expand support to the University, a director of transportation services has been hired and two staff positions filled. In addition to motor vehicles, plans for limited flight services support have been initiated. Clemson has an on-campus fleet of more than 500 vehicles. Vehicle use increased significantly during the year, with a 16 percent increase in mileage over the previous year. Maintenance capability was expanded by two additional work stalls. Progress is also being made toward state certification of on- and off-campus maintenance shops belonging to departments having special vehicle/equipment requirements.

The State Department of Motor Vehicle Management cited Clemson University Transportation Services as having the best facility for environmental and safety working conditions in the state.

### **University Bookstore**

Plans were developed for the renovation of the bookstore beginning in 1989-90, to include modernizing the entrance, improving lighting, providing more spacious aisles and adding cash registers equipped with laser scanners.

## **Facilities Planning and Management**

This program area includes planning, engineering, maintenance and management activities of Clemson University's facilities, including campus master planning, real estate development, property records and capital building projects.

Progress on campus building and renovation programs continues in line with the six-year facilities plan, representing almost \$300 million in projects, approved in September 1987. Projects now in design include the Brackett Hall renovation, East Campus housing, the Academic Learning Center, the Animal Compliance Facility, Johnstone Hall renovation, the Engineering Innovation Center and the Performing Arts facility. Several new projects are scheduled for agriculture, including a new insectary, replacement of a fruit research station and renovations to Newman Hall. In addition, a request for proposals has been issued for a generic research building to be located at the Research Park.

A computer study, a space utilization study, a comprehensive facilities audit and the use of new, alternative construction contract administrative methods are being implemented.

## **Human Resource Services**

### **Capital Financing**

The Office of Capital Financing manages and directs the University's long-term capital financing program and financial information system for all present and future University capital projects.



During FY 1988-89 major accomplishments included:

- Development and preparation of Volume 3 of the *Clemson University Financial Report—Bonded Indebtedness*. This was the first issue of this volume. In addition, various schedules pertaining to permanent improvements and long-term financial debt were prepared for Volume 2 of the *Clemson University Financial Report*.
- Preparation and distribution of forecasts of future revenues for capital financing.
- Sale of \$7,755,000 in Series L Clemson University Student and Faculty Housing Revenue Bonds to finance new student housing on east campus. This saved an estimated \$1.2 million by reducing the maturity and leveling total debt service payments.
- Assistance to the Housing Office in securing a \$1.5 million loan from the Department of Education to remove asbestos from Lever Hall.

### **Payroll and Employee Benefits**

The Office of Payroll and Employee Benefits — with the assistance of the Division of Administrative Programming Services, Publications and Graphics, Personnel Services and others — produced the second personalized employee benefits booklet for each permanent full-time University employee. Containing a number of improvements over the 1988 booklet, *Your Personal Statement of Benefits 1989* was distributed to University employees in April 1989.

The Payroll and Employee Benefits Office expanded the IRC Section 125 “cafeteria plan” to include long-term care, out-of-pocket medical expense and day care for University Employees effective January 1, 1989. This program allows an employee to pay health, dental, long-term care, out-of-pocket medical and day-care expenses with before-tax dollars, resulting in an approximate savings of 28 percent for employees with these expenses.

In May 1989, working with the Faculty Senate, the office conducted a comprehensive employee benefits study, which compared South Carolina benefits to those of 14 other universities in 10 other states. Comparisons were made on benefits for health insurance, dental insurance, disability insurance, life insurance and pre-retirement death benefits, retirement plans, tax-deferred savings programs, paid leave benefits, unpaid leave benefits and other benefits such as library resources, special tuition programs, etc.

To provide information about social security benefits and programs, the Payroll and Benefits Office distributed a booklet to all University employees entitled *Social Security — How It Works For You*. All active employees who were 65 years old this year received a copy of *Medicare 1989*, which explains benefits in simple, practical terms. All employees who were age 65 prior to July 1, 1989, were notified about the supplemental premiums they would have to pay with their 1989 federal tax returns with respect to the new Catastrophic Medicare Health Law.

### **Risk Management and Safety**

In addition to providing services in the areas of property and liability insurance and loss control, safety and workers’ compensation, the staff of Risk Management and Safety hosted the Southeast Region University Risk Managers’ Conference. The office



added a director of environmental health and safety during the year. The department conducted an environmental audit of campus and education and research centers and a computer center risk analysis. Informal training sessions were held with departments on hazard communication standards. Hazardous waste removal expenditures totaled \$145,500 during fiscal year 1988-89.

As part of the State Fleet Safety Program, the department chaired the accident review board and provided defensive driving classes to more than 500 participants, more than 70 safe driver certificates and/or lapel pins were awarded to University employees. The department produced and distributed a *Safety Newsletter* outlining new regulations of the Safer Highways Act and participated in the Governor's Red Ribbon Campaign against drunk driving by distributing ribbons to employees and attaching ribbons to University vehicles. In compliance with state regulations, the department collected driver's license numbers of University employees.

In the area of worker's compensation, the department conducted workers' compensation training sessions and liability insurance seminars. Safety seminars were organized for employees, and supervisors were trained on timely reporting of claims. Workers' compensation handbooks were distributed to departmental secretaries, and OSHA reports were prepared for 170 departments.

### **Personnel Services**

Some of the training and recognition programs for FY 1988-89 offered by Personnel Services were:

- Interviewing Workshops for Supervisors.
- New Staff Employee Orientation Program.
- Employee Performance Management System.
- Pre-Retirement Orientation.
- Prospective Retiree Planning Meeting.
- Professional Secretaries International.
- Employee Recognition Program within Business and Finance giving:
  - Outstanding Performance Awards
  - An annual awards banquet to recognize all the exempt and non-exempt award winners for the year (held annually in September).

Some of the new policies and procedures developed were the Employee Performance Management System (EPMS), Drug Free Workplace, Grievance Procedures I and II, Anti-Kickback Regulations, and the Leave Transfer Program.

The Minority Intern Program was developed to allow Clemson University's minority employees with high potential an opportunity to train in other occupations or work on special projects. Some training areas have been identified, and intern applicants have become involved in the program.

### **Wage and Salary Administration**

The Office of Wage and Salary Administration implemented 429 reclassification/salary adjustment requests and grade reallocations totaling \$754,090 in salary increases



for classified employees. In coordination with Personnel, Payroll, and the Division of Administrative Programming Services, annual salaries were incorporated for hourly paid employees, resulting in a salary increase for most hourly paid employees.

A Position Description (PD) Workshop was conducted to inform employees on the use of the PD, writing an effective PD and common problems associated with PDs.

### **Information Management**

Information Management is concerned with the development, coordination and maintenance of Business and Finance programs in the area of data processing services, networking, telecommunications, records management, word processing, printing, postal services, institutional research and other related activities. Emphasis during the year has been to direct the evolution and integration of cost-effective information-processing procedures. A special study, designed to develop a strategic plan to meet the current and future information processing needs of Business and Finance, was initiated.

### **Institutional Research**

The Office of Institutional Research established data exchanges with members of the Southern University Group, a consortium consisting of 27 universities, and with more than 25 other universities throughout the nation. The purpose of the data exchanges was to share accurate, comparative data in a number of areas of interest to higher education. Detailed data exchanges were also established with the four major institutions in South Carolina. Comparative studies have been completed on faculty salaries, graduate stipends, faculty workloads and funding formulas. During FY 1988-89 the office published the first annual *Clemson University Fact Book* and established a database containing longitudinal data about Clemson over the past five to ten years. This database will be expanded and maintained and will be made available for access by faculty and staff.

The office completed a study on student/faculty ratios for the Commission on Higher Education and is collecting information from state governing boards across the nation to extend the scope of the project.

The office is serving as an information resource center for University committees on Self Study and Assessment. Institutional Research also represents Clemson University in the South Carolina Higher Education Assessment Network (SCHEA).

### **Telecommunications**

In 1988-89 Communication Services, in cooperation with the University's Telecommunications Steering Committee, negotiated a contract with Southern Bell Telephone Company for continuation of the Digital ESSX service until July 1995. Southern Bell agreed to upgrade the system to a DMS-100 Supernode, the most advanced digital switching system manufactured by Northern Telecom, Inc. Southern Bell also agreed to equip the system to provide voice and high speed data transmission simultaneously over the same pair of wires (ISDN service). Although Southern Bell will be increasing system capabilities, the new contract rates will reduce fixed annual costs by \$42,000.

The Clemson University/Southern Bell agreement also provides for a number of other joint ventures in telecommunications. These include a study of future needs for



telecommunications equipment and services for the classroom, dormitory, office and library; joint research and development of telecommunications equipment and services; development and delivery of new or enhanced telecommunications-related course work; development of a Digital Communications Presentation Center; implementation of an improved network management system; and the design and implementation of a fiber optic based campus distribution system.

Other projects completed during 1988-89 are:

- Completed the conversion of the long distance access lines to T1 carrier facilities. This project reduced annual costs by \$87,300.
- Installed telephones and local area networks in the Strom Thurmond Institute and the IPTAY/Ticket Office complex.
- Replaced telephone wiring in Lever Hall and Mauldin Hall.
- Rewired the data network and relocated the network control center for Sikes Hall.
- Continued with the multi-year project to install more efficient telephone systems in the county Extension Service offices.
- Purchased new personal computers to further automate support systems for the administrative, business and technical staffs.

#### **Administrative Data Processing**

Continued improvements in the Office of Administrative Data Processing include the conversion of data from key to disk, making data entry more accurate and efficient. Future plans involve working with departments to develop procedures whereby data can be entered from their respective areas.

#### **Information Resources**

The Office of Network Services continues to expand networking support and to assist users with personal computer (PC) and mainframe applications. User knowledge of the PC and related software has significantly increased, particularly in the areas of document transfer, desktop publishing, and spreadsheet and database applications.

#### **Information Support Services**

Printing Services provides printing and duplication services to the University. In addition to typesetting, one- and two-color printing, and high-speed photostatic duplication, services include document assembly, finishing, folding, inserting, labeling and bulk mailing. University Printing Services prints and duplicates more than 28,000,000 pieces of paper annually.

The following improvements in Printing Services have been completed in 1988-89:

- A safety awareness program, which focuses on the hazards of chemicals used in Printing Services, has been implemented.
- The addition of a new American Multigraphics Model 1962 two-color offset press allows Printing Services to print enamel-coated paper stocks.
- A new service that provides for the presorting of first class mail with labels generated by GroupI software reduces postage rates.



- The addition of an IBM personal computer has made the computerized inventory system more accurate and efficient.

Postal services are provided on campus by the University Post Office. Both incoming U.S. mail and on-campus mail deliveries are made to students via more than 7,000 boxes located in the post office lobby. Stamp and money order sales, parcel, insured, certified and registered mail services are also provided at the lobby counter. Mail pickup and delivery service is provided to faculty and staff office complexes. The University Post Office, which processes about 40,000 pieces of mail and 250 parcels daily, continues to develop a variety of initiatives designed to improve service and reduce costs.

## **INSTITUTIONAL ADVANCEMENT**

The Division of Institutional Advancement is designed to create and enhance Clemson University's communication and support programs. The division consists of the offices of University Relations, Communications and External Relations, Alumni Relations, Development, and Advancement Services. These units work with the Clemson University Board of Visitors, the Clemson Alumni Association and the Clemson University Foundation to communicate the mission and activities of the University and to enhance its image; to provide service and programming to Clemson alumni and friends and to seek service and broad support from alumni and friends; to attract and manage private financial gifts in support of Clemson's academic and administrative operations; and to manage the constituent database and computer systems necessary for the aforementioned endeavors to occur. A report on each unit follows.

### **University Relations**

Communication is the common theme for the six units that comprise University Relations. These departments provide services in the areas of news and public information, electronic and photographic support, publications and graphics, visitor programs, constituent communications, general public relations counsel, and long-range strategic communications planning for the University's academic and administrative divisions, including the Cooperative Extension Service and the S.C. Agricultural Experiment Station. In addition, many communications projects in 1988-89 were centered around University Centennial events.

### **Agricultural Communications**

The Department of Agricultural Communications serves the communications needs of the public service agencies in the College of Agricultural Sciences. A primary goal is to provide the people of South Carolina information that will help them improve their productivity and standard of living. This is accomplished by providing news articles, columns and features for the general media, both print and broadcast, and for specialized publications; by providing agriculture, health, nutrition, home care and other publications of value to growers, homeowners, families and young people; by devel-



oping exhibits for use throughout South Carolina; and by working with Extension employees to develop their communication skills.

In 1988-1989 the department:

- Produced, in cooperation with the University of Georgia and with USDA grant support, a 15-minute video commemorating the 75th anniversary of the Cooperative Extension Service. The video was aired nationally.
- Developed and executed public relations strategies for Clemson's second field test of a genetically engineered microorganism and the introduction of the potentially controversial Institute for Wildlife and Environmental Toxicology.
- Published the premiere annual reports for the Division of Agriculture and Natural Resources and the Agricultural Experiment Station.
- Launched a biannual tabloid periodical, *South Carolina Agriculture Tomorrow*, covering research issues and activities within the Agricultural Experiment Station.
- Began marketing Clemson's Agriculture and Natural Resources Division through one of Clemson's most popular attractions, the Agricultural Sales Center. This effort included a kiosk featuring an interactive video laser disc system.
- Issued 348 Extension news releases compared with 308 the previous year, an increase of 13 percent.
- Introduced a pilot program supplying 260 produced news stories on tape to nine county Extension directors.
- Handled 625 publication, exhibit and display assignments. That volume is up 27 percent from 491 for 1987-88. Total billing in the publications area for 1988-89 was \$266,719, only \$862 of which was used for typesetting.
- Surpassed for the first time the one-million mark in publications distributed through the Bulletin Room in a year, with 1,149,405 pieces — up 172,809, or 18 percent, from 1987-88.
- Received regional and national recognition. Presented the Grand Award for best general news story or series in the nine-state region by the Council for Advancement and Support of Education (CASE), for the second consecutive year, as well as a national Bronze Medal. The department also won five of 92 national awards in the Agricultural Communicators in Education annual competition.

### **Constituent Communications**

The role of the constituent communications program in University Relations is to help the University keep constituent audiences (primarily alumni, donors and other supporters) informed and educated about Clemson. The major products of this effort are the periodical publications *Clemson World* magazine (circulation 32,000) and *Clemson World News* tabloid newspaper (circulation 80,000). Staff members also provide editorial and communications counsel and support for special projects, such as the University's Centennial celebration. In FY 1988-89, the program:

- Completed phase II of a five-year plan to improve the periodicals by naming an Art Director, establishing an Editorial Advisory Board and planning an increased advertising support effort.



- Prepared and published four issues each of *Clemson World* and *Clemson World News*, including special issues on private support (the "Honor Roll" issue) and a special souvenir double-issue magazine on the Centennial.
- Assisted the president, vice presidents and other administrators with special communications projects, as needed, including the *President's Report*, *President's Letter* (a biweekly newsletter) and notes for speeches.
- Provided leadership for planning, executing and publicizing major Centennial events, particularly the "Report to the People" dinner and Cornerstone Weekend; produced 13 Centennial television spots in conjunction with WYFF-TV; arranged the Centennial photograph of the 1988-89 student body.
- Provided communications counsel and leadership for academic fund-raising activities, including preparation of support materials and the announcement of major gifts (e.g., announcement of the Roy and Margery Pearce Center for Professional Communication).
- Assisted Alumni Relations and the Development office with special communications and newsletters for major donors and Clemson Club officers.

### News Services

The Department of News Services provides the University with a means of communication to the public through external news media. Staff members generate news and feature stories about the University's educational, public service and research programs for use by state, regional and national news media and in constituent publications, such as *Clemson World* magazine, and *Clemson World News* tabloid, and the faculty-staff newsletter. Services also include editing and marketing faculty-written columns and book reviews; coordinating coverage of campus events, speakers and Board of Trustees meetings; conducting news conferences and major public relations campaigns; acting as liaisons between the University and the print and broadcast media; and providing media training for Clemson faculty, staff and administrators.

In 1988-89, News Services produced:

- 311 general news releases.
- 46 news weekly media tip sheets.
- 26 history book review columns.
- 47 children's book review columns.
- 51 "Living Well" columns.
- Seven editorials.
- Two feature packets (back-to-school, 15 releases; Christmas, 9 releases).
- 1,052 hometown news releases.
- 41 regular and 18 special issues of *Clemson Weekly*, the faculty-staff newsletter.
- Daily "Executive News Briefings."
- Daily "Clemson Daybook" tip sheet.



- Public relations plans and arrangements for the Centennial, the Strom Thurmond Institute dedication featuring Vice President Dan Quayle, and numerous research features, news conferences and major-gift announcements.

### **Electronic and Photographic Services**

The Department of Electronic and Photographic Services (commonly known as the Communications Center) provides a broad range of audio and visual production services to support the public service, administrative, development, research and instructional activities of the University.

Services include television, audio, multi-image, photographic, motion picture production, audio and video teleconferencing, art and graphic support and audio visual equipment and resources loans.

In 1987-88 the department:

- Produced 749 television programming units.
- Produced 43,187 photographs and 31,830 slides.
- Completed 2,493 art and graphics jobs representing nearly 20,000 individual pieces of artwork.
- Produced 260 daily "Plant Professor" radio programs and 52 "Living Well" programs distributed to stations statewide.
- Produced nearly 50 multi-image presentations.
- Increased the Media Library's holdings to 2,210 titles and averaged 57 loan transactions per week.
- Complied with an average of 60 requests per week for items from the Audio-Visual Equipment Loan Service.

### **Publications and Graphics Services**

The Department of Publications and Graphics Services ensures that Clemson University's printed communications maintain the highest standards of writing and design and that they project an accurate image to the University's various publics.

In 1988-89 the department:

- Completed 425 projects (including 30 for the Centennial and 15 for the Strom Thurmond Institute dedication).
- Bought approximately \$460,000 in printing and related services — a 7.5 percent increase over the amount reported for last year.
- Designed and produced the 1987-88 *President's Report*, which won a CASE III Grand Award.
- Recruited, hired and trained an art director for the *Clemson World* and *Clemson World News*.
- Networked the department's Apple Macintosh computers, allowing exchange of files and individual access to the VAX and mainframe.
- Brought job tracking database in-house to run on the department's network.



- Continued developing expertise in desktop publishing. More than 90 percent of the department's publications are designed or formatted on the Macintosh.

### **Visitor Programs**

Visitor Programs administers the Visitors Center, Board of Visitors activities and two campus landmark houses — Fort Hill and Hanover House. The University's full-service Visitors Center provides a variety of services to meet the information needs of an increasing number of campus visitors. Services include general information, guided and self-guided tours, audio-visuals, and publications. Through the Board of Visitors program, prominent civic and business leaders serve as advisers to the University, visit the campus for updates on programs and priorities, and help provide a two-way communications link between the University and the public. Members of the board are assigned to four committees: academic affairs, legislative relations, media and research. The historic Fort Hill and Hanover House are open to the public throughout the year.

In 1988-89:

- The Visitors Center served 21,859 people, conducted 468 regularly scheduled guided tours, arranged an additional 217 tours, and both arranged and guided 92 special tours.
- The Board of Visitors met twice in full session, held a one-day reunion March 4, 1989, for all Board members since 1984, and hosted a legislative reception in Columbia January 25, 1989, prior to the "Report to the People" program.
- 12,817 people visited Fort Hill and 1,763 visited the Hanover House.

### **Alumni Relations**

The Alumni Relations Office provides a variety of programs and services for Clemson alumni, friends, students and students' parents. The 1988-89 highlights of each programmatic area are listed below:

#### **Alumni Programs**

This area is responsible for planning, directing and overseeing all campus-based alumni-related programs and for working with special groups of alumni and students, such as the Young Alumni Associates, the Student Alumni Council and the Clemson Black Alumni Council.

In 1988-89:

- There were 50 Young Alumni activities in 15 cities with an average attendance of 50 at each event. Among other accomplishments, the Young Alumni Associates upgraded their awards program to recognize top high school students and encourage them to choose Clemson. The Thomas Green Clemson Award program was established to recognize a graduating senior chosen by the guidance counselor for excelling in academics, community service and as a student leader. Personalized plaques were awarded to 75 recipients in Greenville, Spartanburg, Columbia, Florence, Charleston and Charlotte.



- The Student Alumni Council hosted the Welcome Back Festival to start the academic year, conducted the ninth Orange Carpet Day for outstanding high school students, and selected Dr. Patti Connor Greene, a professor of psychology, as the 1989 Alumni Master Teacher.
- The staff planned and produced Reunion Weekend '89 with more than 700 alumni and friends attending.
- The Clemson Black Alumni Council organized and sponsored the Gantt Scholars Dinner on September 2 to announce the scholarship endowment for black students and to mark the 25th anniversary of the enrollment of Clemson's first black student, former Charlotte, N. C. Mayor Harvey Gantt. More than 700 attended the event. CBAC also hosted a spring meeting with 50 people attending and a reception for graduating black seniors with more than 100 people attending.
- More than 9,000 Clemson Credit Cards (special VISA and MasterCard charge cards) have been issued under an agreement with South Carolina National Bank.
- The 1989 Clemson Travel Program incorporated a continuing education focus on five of the six programs offered.
- Various campus groups used the Clemson Alumni Center for education and administrative purposes.

### **Field Activities**

This area is responsible for planning, directing and overseeing off-campus, alumni-related programs, with particular emphasis on encouraging the development and growth of locally based Clemson Clubs throughout the state, region and nation.

In 1988-89:

- There were more than 150 Clemson Club activities around the country. There are currently 30 active Clemson Clubs as compared to 18 last year. Seventeen clubs have been chartered (have a formal constitution, hold at least two meetings annually and have a basic mission to serve Clemson). During fall and spring Clemson Club meetings, more than 9,000 alumni and friends were served. High school receptions were hosted by 10 clubs.
- The second Clemson Club Officers' Training Weekend attracted participants from 24 clubs for educational sessions about club development, operation and programming. A Leadership handbook was also introduced.
- Alumni Headquarters and related events were provided for five regular-season away football games, the Citrus Bowl and the Atlantic Coast Conference basketball tournament. More than 2,300 alumni and friends were served.
- More than 11,000 alumni received the weekly *Alumni Career Services Bulletin* of career opportunities.

### **Special Events**

This area assists all Institutional Advancement departments and other University divisions in planning and producing special events (on and off campus) to enhance Clemson's image and to meet particular constituent or program needs.



In 1988-89:

- The Clemson Alumni Association and City of Clemson co-hosted a reception in August to welcome new faculty members to the campus and community.
- The third annual Clemson Parents' Weekend was held, with almost 3,000 parents participating.
- During the 1988 football season, the Office of Special Events coordinated all activities for the President's Box.
- The number of graduating seniors returning their information cards increased from 50 percent to 60 percent.
- Organized the second annual Keowee Key Clemson Club trip to Charleston with 49 people participating.
- The ninth annual Clemson Medallion Dinner attended by 375 people, was held in March honoring Sam Liles and Phil Prince.
- Special events were held for each of Clemson's three major gift clubs.
- Dedication ceremonies for the Strom Thurmond Institute were held in April.
- The staff assisted with numerous other special events from Homecoming to graduation.

### **Development Office**

The objectives of Clemson's private support efforts are deliberate and broad-based. They encompass growth in the unrestricted permanent endowment, expansion of all phases of general and endowment support for faculty, increased sources of student financial aid and further development of the annual Loyalty Fund program, which enhances the total academic environment. While state appropriations are a part of the total support for the educational activities at Clemson, more than 50 percent of the total budget must come from other sources. In that context, the ultimate quality of the University rests with private support from business, industry, alumni and friends of the University.

In 1988-89:

- Private gifts for Clemson's academic programs jumped 21.4 percent, reaching \$12.5 million and crossing into double digits for the second time in history.
- Unrestricted giving to the annual Clemson Loyalty Fund topped \$1.2 million for the first time ever.
- A record number number of individuals — 16,321 — made annual gifts to current operations. The average of these gifts was \$169.
- Of Clemson's alumni of record, 28.5 percent — twice the national average for state-assisted schools — participated in the Loyalty Fund.
- New gifts were received from 3,643 donors who had never given before.
- Of the \$12.5 million total, \$6.6 million came from individuals, \$5.9 million from corporations, foundations and trusts.



- A total of 21,399 gifts — including gifts for annual operations and for capital purposes, from individuals and from organizations — were received in 1988-89. The average gift from all sources was \$587, up 47 percent from last year.
- Total expenditures relative to year-end fund-raising results indicate a cost of 10 cents to raise each dollar.

The year was highlighted by several large contributions from both individuals, corporations, and foundations. The establishment of the R. Roy and Margery Pearce Center for Professional Communication, and the establishment of the John Archbold Center for Tropical Studies were evidence of two major private initiatives in 1988-89.

### **Advancement Services**

The Office of Advancement Services was created in 1987 to provide support for the offices of Development, Alumni Relations and University Relations. It was charged with the functions of gift receiving, gift processing, endowment management and database management for the development, alumni and media databases. It was also charged with the responsibility for maintaining the alumni and development data systems.

In 1987-88, most activity in Advancement Services centered around staff recruitment and training, systems analysis and program upgrading, the development of financial policies and procedures, and the introduction of systematic financial analysis. In 1988-89, activity continued in those areas.

The year also saw the organization of personnel into two units. The director of donor research was given the additional responsibility for all database services and systems maintenance as well as the Research Office. This group concerns itself primarily with non-financial, biographical data. The gift-processing and financial-management functions were organized under the director of accounting services.

Two additional areas — financial analysis and planning and management of the Foundation's \$33 million endowment — were important priorities for the year as well.

More specifically, the Office of Advancement Services featured the following:

- In its first full year of operation, the Office of Donor Research developed a reference library, in which published references are complemented by on-line databases and other research tools. Comprehensive profiles of prospective donors were developed and updated.
- Data-entry protocols were introduced; data programs were substantially rewritten; and preparations were made for a comprehensive alumni survey. The Accounting Services group made further improvement in meeting tighter standards for daily gift processing and reporting. Additional financial controls were introduced. Regular reporting on operating and endowment accounts was begun.
- Analysis was conducted on data-processing and gift-processing efficiency. An experiment with machine-read barcoding was completed. Plans were made for the broad application of barcoding in the next year.
- Additional analysis was conducted on the cost of raising funds for the Development Office.



## STUDENT AFFAIRS

The 1988-89 academic year marked the highest (total) University enrollment with 14,794 students registered for classes — 12,542 full time and 2,252 part time. This represents an increase of over 6 percent from last year. Of the total enrollment, 3,020 were graduate students.

The College of Commerce and Industry had the highest collegiate enrollment with 3,619 students. The College of Engineering was second with 3,544, followed in order by Sciences (1,545), Education (2,264), Liberal Arts (1,512), Agricultural Sciences (721), Architecture (653), Forest and Recreation Resources (521) and Nursing (332). Higher education continued to become increasingly accessible as evidenced by the number of freshmen entering college with advanced standing. In the 1988-89 fall semester, new high school graduates entered Clemson with advanced standing by means of College Board Advanced Placement courses (718 students, 6,286 credit hours) and by concurrent enrollment in high school and college or enrollment in summer school (146 students, 694 credit hours).

At Clemson, performance in high school has proven to be the best single predictor of success in the freshman year. The class ranks of entering freshmen remained essentially unchanged, with 33 percent of the class entering in fall 1988 ranked in the top 10 percent of their class, 58 percent in the top 20 percent and 94 percent in the top 50 percent. The freshman class average Scholastic Achievement Test (SAT) score of 1,032 compared with an average of 904 reported by the College Board for all high school seniors. It is also the highest average among state-supported institutions in South Carolina.

Of the 9,269 new applications for admission processed for 1988-89, 6,242 were accepted, and 3,449 actually enrolled (including freshmen and transfer students). Clemson students come from all 46 South Carolina counties, 49 states, Puerto Rico, the District of Columbia, and 74 foreign countries.

South Carolina residents accounted for 66 percent of the 14,794 students. Greenville County continued to have the most students enrolled on campus (1,288). Pickens County was second with 1,002, followed in order by Anderson, Oconee, Spartanburg and Charleston counties. Most out-of-state students came from Georgia (611), North Carolina (543) and Florida (510).

Computerized pre-registration helped the record number of students get off to a smooth start for fall classes. Approximately 86 percent were pre-registered and had their course schedules completed before they arrived on campus to begin classes.



### Fall Semester Enrollment Comparisons for Recent Years

Year	Undergraduate	Graduate and Others	Total
1972-73	7,686	2,071	9,757
1973-74	7,910	2,202	10,112
1974-75	8,171	2,415	10,586
1975-76	8,576	2,785	11,361
1976-77	8,620	2,763	11,383
1977-78	8,708	2,566	11,274
1978-79	8,925	2,553	11,478
1979-80	9,291	2,457	11,748
1980-81	9,427	2,152	11,579
1981-82	9,918	2,008	11,926
1982-83	10,151	1,983	12,134
1983-84	10,217	2,242	12,459
1984-85	10,488	2,438	12,926
1985-86	10,434	2,459	12,893
1986-87	10,360	2,702	13,062
1987-88	10,970	2,895	13,865
1988-89	11,774	3,020	14,794

The enrollment of women at Clemson reached an all-time high during the 1988 fall semester. There were 6,443, of which 5,061 were undergraduates. Enrollment of undergraduate women increased more than 6 percent from last year, and women now constitute approximately 43 percent of the undergraduate enrollment.

The Clemson student body continues to be a working group, receiving a significant amount of financial assistance through loans, grants, scholarships and employment. Clemson awarded 462 long-term loans totaling \$549,625. The University also approved and certified 3,493 guaranteed student loans from a variety of lending institutions. Excluding donor-selected scholarships, 1,333 scholarships and grants valued at \$1,250,083 were awarded. The number of students receiving Pell Grants was 1,593, with awards totaling \$2,235,182. In all, about 68 percent of the student body received an estimated total of \$22 million in financial assistance.

Student government continues to add new programs for the student body. Approximately 350 people this year represented the students in the senate, in the judicial system, on executive committees, and 95 students were appointed to University committees. The coin-operated copier machines continue to provide revenue for other student-operated services.

The TAPS yearbook, *The Tiger* newspaper, WSBF radio and *The Chronicle*, Clemson's variety magazine, continue to offer positive outlets for students' creative energies. TAPS sold more than 6,500 copies, with the 656-page Centennial issue being the largest ever produced.

Clemson's 12 sororities and 18 fraternities remained steady in popularity in 1988, claiming approximately 20 percent of the undergraduate population as members. Completion of the renovations of a floor in Fike Center secured office and lounge space for the Pan Greek Council groups. The Interfraternity Council lost one member group to discipline, but gained one organization (Delta Chi) through formal expansion.



The Counseling and Career Planning Center had a successful final year. The Counseling Center will continue in 1989 to expand its services for personal adjustment counseling, self-improvement concerns and assistance with performance issues such as test anxiety, motivational problems, learning style assessment, etc.

The Career Services and Placement Office provides students with information on career opportunities, teaches job search skills, assists students looking for summer jobs/internships and coordinates industry contacts with the University. Last year, students conducted more than 7,000 job interviews with more than 400 employers.

Effective July 1, 1989, the career planning portion of The Counseling Center was transferred to Career Services, and the department was renamed the Career Center. There will be a renovation project to provide additional office space and improve existing facilities. This is funded in part by \$45,500 in donations from industry to the Career Center.

The University Union continues to provide a wide variety of programs and activities designed to serve the needs, interests and developmental skills of students. The Union provides students an opportunity to develop leadership skills, communication skills, business and interpersonal relationship skills, while providing many worthwhile programs and services for the total campus community.

The Union has more than 250 student volunteers working to provide programs, and in 1988-89 provided more than 805 Union programs on campus. The year's highlights included the development of a Minority Programming Committee for the Union Board, which provided a variety of interesting programs during the year. The Union also developed a new Entertainment Committee to program contemporary music and entertainment, which provided 25 percent more programs than the previous year. Highlighting the year's Performing Artists Series was Jerry Clower, who opened a six-part series of a variety of Performing Arts programs.

Clemson was one of just eight teams in the nation to play in a bowl game, the NCAA basketball tournament and the NCAA baseball tournament, testimony to Clemson's all-round sports program. Clemson tied the ACC record for overall conference championships this year with seven. The Clemson football, baseball, men's outdoor track, men's indoor track, men's cross country, men's tennis and women's swimming teams all won ACC titles.



**Number and Percent  
of Black Students**

Year	Number	Percent
1972	179	2
1973	211	2
1974	216	2
1975	338	3
1976	307	3
1977	336	3
1978	290	3
1979	341	3
1980	305	3
1981	325	3
1982	429	4
1983	472	4
1984	528	4
1985	671	5
1986	714	5.47
1987	690	5
1988	789	5.3

**Average College Board  
of Freshmen**

Year	Score
1972	995
1973	982
1974	984
1975	983
1976	996
1977	985
1978	1,000
1979	1,002
1980	1,005
1981	1,007
1982	1,017
1983	1,014
1984	1,012
1985	1,012
1986	1,025
1987	1,028
1988	1,032

**Student Faculty Ratio  
(Full-Time Equivalent)**

Year	Ratio
1972	14.6:1
1973	16.8:1
1974	17.9:1
1975	18.3:1
1976	17.6:1
1977	16.3:1
1978	15.9:1
1979	16.0:1
1980	15.6:1
1981	16.4:1
1982	16.6:1
1983	17.0:1
1984	16.1:1
1985	15.4:1
1986	16.9:1
1987	18.3:1
1988	18.9:1

**Number in Freshman Class  
(New Students)**

Year	Number
1972	1,919
1973	2,034
1974	1,949
1975	1,901
1976	1,861
1977	1,838
1978	2,020
1979	1,998
1980	2,008
1981	2,284
1982	2,321
1983	2,122
1984	2,188
1985	2,259
1986	2,239
1987	2,818
1988	2,885



**Number of Teachers  
(Full-Time Equivalent  
Teaching Faculty)**

Year	Teachers
1972	614.9
1973	578.4
1974	591.8
1975	602.5
1976	611.3
1977	654.4
1978	675.6
1979	691.8
1980	718.2
1981	709.7
1982	720.9
1983	713.5
1984	762.5
1985	797.3
1986	731.24
1987	713.93
1988	755.48

**Number of Dorm Beds  
and Percent Being Used**

Year	Beds	Percent
1972	5,174	100
1973	5,330	102
1974	5,592*	101
1975	5,616*	103
1976	5,625*	103
1977	5,662*	103
1978	5,683*	104
1979	5,726*	106
1980	6,317*	112
1981	6,864*	100
1982	7,149*	105
1983	7,113*	104
1984	6,976*	102
1985	6,986*	102
1986	6,910*	101
1987	7,047*	103
1988	7,125*	104

\* Includes beds in the Clemson House.

1974 - 252	1982 - 328
1975 - 262	1983 - 331
1976 - 271	1984 - 331
1977 - 308	1985 - 333
1978 - 317	1986 - 349
1979 - 324	1987 - 360
1980 - 329	1988 - 362
1981 - 330	

**Number of On-Campus Students  
in Summer School**

Year	Number
1972	5,232
1973	6,267
1974	5,997
1975	6,275
1976	6,100
1977	6,301
1978	6,393
1979	6,708
1980	6,858
1981	6,897
1982	7,149
1983	7,442
1984	7,418
1985	8,126
1986	8,562
1987	8,446
1988	8,689



**Fall Semester 1988 Enrollment by Colleges and Degrees Awarded  
December 1987-August 1988**

	Total Enrollment Fall Semester	Degrees					Total
		Associate	Bachelor's	Master's	Specialist	Doctorates	
Agricultural Sciences	721	0	70	61	0	19	150
Architecture	653	0	89	47	0	0	136
Commerce and Industry	3,619	0	569	98	0	5	672
Education	2,264	0	190	154	7	5	356
Engineering	3,544	0	440	133	0	15	588
Forest and Recreation Resources	521	0	84	21	0	2	107
Liberal Arts	1,512	0	183	14	0	0	199
Nursing	332	0	80	15	0	0	95
Sciences	1,545	0	216	80	0	27	323
Non-Degree	83						
Total	14,794		1,921	623	7	73	2,624

Degrees awarded since 1986 (through August 1988) total 65,293: 426 have been associate degrees; 52,234 bachelor's degrees; 11,511 master's degrees; 148 education specialist degrees; and 974 doctorates. Includes 544 Clemson-Furman MBA degrees awarded May 1972-August 1988.



# 1988-89 Clemson Sports

Sport	Home	Away	Neutral	ACC	Overall	Pct.	ACC Regular Finish	ACC Trn. Finish	National Ranking	1st Team All-ACC Players	All- American Players
*Football	15-1	4-1	1-0	6-1	10-2	.833	1st	NA	9th	4	1
Soccer	9-5-2	1-2	—	2-5	10-7-2	.579	5th	5th	—	1	0
Women's Cross Country	—	—	—	—	—	—	NA	2nd	18th	1	0
*Men's Cross Country	—	—	—	—	—	—	NA	1st	4th	4	2
Volleyball	12-4	4-6	5-9	2-4	21-19	.525	3rd	T3rd	—	0	0
Men's Basketball	13-1	4-8	2-2	7-7	19-11	.633	6th	T5th	#24th	0	0
Women's Basketball	9-3	7-7	4-1	9-5	20-11	.645	4th	T3rd	13th	0	0
Wrestling	6-1	4-6	3-2	3-2	13-9	.591	3rd	3rd	30th	3	1
*Women's Swimming	7-0	3-1	2-1	5-0	12-2	.857	1st	1st	9th	8	6
Men's Swimming	6-2	3-1	2-1	5-1	11-4	.733	1st	3rd	31st	5	0
Women's Indoor Track	—	—	—	—	—	—	NA	2nd	—	3	0
*Men's Indoor Track	—	—	—	—	—	—	NA	1st	8th	10	7
*Baseball	27-5	13-11	10-4	13-5	50-20	.714	2nd	1st	14th	2	1
Women's Tennis	7-10	2-2	1-6	5-2	10-18	.357	4th	4th	—	1	0
*Men's Tennis	8-2	6-2	11-7	7-0	25-11	.694	1st	1st	13th	4	3
Women's Outdoor Track	—	—	—	—	—	—	NA	3rd	—	6	0
*Men's Outdoor Track	—	—	—	—	—	—	NA	1st	23rd	11	3
Golf	—	—	—	—	—	—	NA	5th	3rd	2	2
Men's Totals	74-17-2	35-31	29-16	43-21	138-64-2	.681	3 Firsts	5 Firsts	7 Top 20	49	20
Women's Totals	35-17-0	16-16	12-17	21-11	63-50-0	.557	1 First	1 First	2 Top 20	22	6
Overall Totals	109-34-2	51-47	41-33	64-32	201-114-2	.637	4 Firsts	6 Firsts	9 Top 20	71	26

\*Indicates ACC Champion

#Indicates Dunkel Ranking



## **UNIVERSITY RESEARCH**

The Office of University Research provides information and assistance concerning all aspects of the University research effort to faculty members, departments, colleges and other administrative units. The office helps prepare and submit applications for sponsored research, instruction and public service programs. During 1988-89 the office processed more than 600 proposals to a variety of potential sponsors and coordinated the review process for four internal grant programs.

The office also provided University liaison between the institution and all public, private, national and local organizations or entities concerned with research support, regulation or administration. The office sponsored campus visits by representatives of government agencies, industry organizations and foundations during the past year.

An electronic bulletin board was established to provide faculty with timely information on research funding. Guidance and executive support were provided to the Clemson University Patent Committee.

### **Department of Research Services**

The department was established in 1989 to (1) coordinate institutional compliance with federal laws regulating the use of animals and humans in research, teaching and testing activities and (2) provide professional and technical support for research activities involving animals used in research, teaching and testing.

Director, Dr. Harold E. Farris serves as director of research services. He is a veterinarian with advanced training and experience in the humane care and use of laboratory animals and biomedical research.

#### **Compliance Responsibilities**

All research, teaching and testing programs involving animals must comply with the Animal Welfare Act, PL 89-544 and the Health Research Extension Act of 1985, Public Law 99-158. Compliance involves institutional review and approval of all animal-use protocols, monitoring of animal use and provision of appropriate veterinary care.

Research Services coordinates the review of animal-use protocols and performs extensive recordkeeping and reporting required by federal laws. (Clemson research programs include 150 animal-use protocols.)

Research Services serves as the University human subjects protection office. The department coordinates committee review and monitoring of 85 protocols involving human subjects. The review, recordkeeping and reporting activities provided by Research Services are required under the Code of Federal regulations 45 CFR 46, Protection of Human Subjects.

A third regulatory responsibility has been assigned to Research Services. In July 1989 the institution appointed a campuswide Biosafety Committee to review all research proposals involving recombinant DNA, biological, chemical and radioactive hazards in accordance with new federal guidelines. Research Services is responsible for the recordkeeping and reporting activities of this committee.



**Services Responsibilities**

Research Services is responsible for planning and developing centralized animal research and teaching facilities and programs. Program planning for new agriculture and biomedical research and teaching facilities was initiated in January 1989. The director of research services is responsible for the professional oversight of the planning and design of the facilities. Research Services will be responsible for centralized professional and technical direction and technical operation of the new \$5.4 million facilities.

**Accomplishments**

- A comprehensive institutional policy to respond to public inquiries regarding use of animals has been developed (in the past year numerous research facilities on college campuses across the country have been vandalized or destroyed by animal rights activists).
- Computerized recordkeeping has been implemented for all committees. Appropriate review forms are being developed to ensure that Clemson remains in compliance with the many federal regulations affecting use of PHS grant money. Non-compliance in a single area can result in the withholding of all federal funding.